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ORIGINAL ARTICLES.

I.—Preliminary Note on a New Artiodactyle from Majorca, *Myotragus balearicus*, gen. et sp. nov.

By Dorothea M. A. Bate.

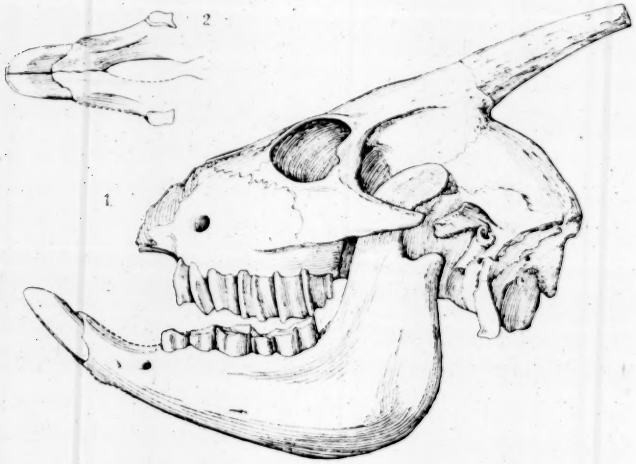
(with four text-figures.)

In March of the present year (1909) the Rev. R. Ashington Bullen, who was then travelling in Majorca, wrote to inform me of the existence of a supposed ossiferous breccia situated on the east coast of that island. This caused a long-deferred project of exploring the Balearic Islands in search of Pleistocene cave-deposits to be carried out, and a month was spent in this manner, although a much longer period would be required for an exhaustive examination of Majorca alone, which was the only one of the group visited. A considerable tract of limestone country was investigated, and the result was the discovery of three ossiferous cave-deposits, including the one mentioned above. Similar remains were procured from each of these, and on examination prove to be those of an ungulate which appears to be without parallel. No great quantity of material was obtained, but this fortunately includes a well-preserved skull of an old individual with the associated mandible and atlas vertebra—the type-specimen, see Fig. 1—as well as a number of perfect examples of various limb-bones.

I hope shortly to be able to communicate a detailed account, with figures and full descriptions, of this collection, but for the present must confine myself to noting the more striking peculiarities of the skull and limb-bones without entering into the questions of affinity and descent. It will be seen from the illustration that the skull and horns are those of a small goat-like animal, while the same may be said of the molar series. The most striking peculiarity of the dentition is that the mandible carries a pair of large and permanently growing rodent-like median incisors, the other incisors and the canine being entirely wanting; it was this which suggested the name for the new genus which seems to be required for the reception of this animal, while the specific name denotes its habitat. It is proposed that it shall be called *Myotragus balearicus*.

The profile view of the skull given in Fig. 1 shows that although the molars approach in size to those of the common goat, the whole

skull is characterized by what may be described as a general 'shortening' both before and behind the orbit, the position of which is very high, while its margin is slightly prominent. The lachrymal is short and wide, and the portion of the malar situated in front of the orbit is greatly reduced, causing the eye to be placed very far forward. The opening of the auditory meatus is extremely small. Two roughened projections occur on the upper border of the foramen magnum. The horns, which arise entirely from the frontals, are short and circular in section, the one preserved in the figured specimen measuring 49 mm. (incomplete at tip) in length and 50 mm. in circumference at its base.



Myotragus balearicus, gen. et sp. nov.

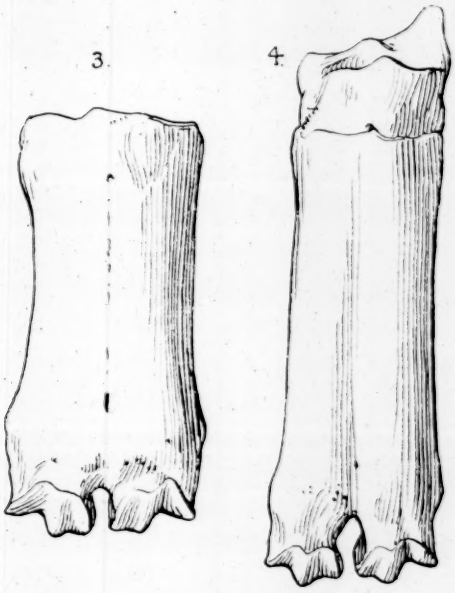
Fig. 1. Skull and mandible from left side. Type-specimen, ½ nat. size.
,, 2. Anterior end of mandible, showing the cutting incisors. ½ nat. size.

The cheek-teeth series measures antero-posteriorly about 48 mm., the upper series being shortened by the presence of two premolars only, by the second molar being very much smaller instead of nearly equal in size to the third, and by the first molar consisting of only one pair in place of two pairs of crescent-shaped columns. Only one premolar is present in the lower jaw, making the number similar to that obtaining in many rodents. Therefore the dental formula of *M. balearicus* is as follows:—

i. ? p.m. 2. m. 3.
i. 1. p.m. 1. m. 3.

The ventral border of the massive mandible is convex throughout, its length causing the anterior teeth to project upwards to an extent that suggests that the animal's nose must have been very short. The symphysis of the mandible, apparently, was very strong. The two large rodent-like median incisors were doubtless ever-growing, and penetrate the jaw for a considerable distance, beneath the diastema and as far as to below m. 1.

As in rodents, it is their outer surface only which has a coating of enamel, which is slightly grooved longitudinally, and it is this enamel which forms the cutting edge of these two teeth, and the worn surfaces together take the form of a semicircle or crescent-shaped space, as shown in Fig. 2.



Myotragus balearicus, gen. et sp. nov.

Fig. 3. Metacarpal, front view. Nat. size.
,, 4. Metatarsal with distal tarsals, front view. Nat. size.

The general shortening and thickening already mentioned as being so noticeable in the skull appears to have been characteristic of the whole animal, for this tendency is also very strongly marked in the limb-bones. Figs. 3 and 4 show respectively the metacarpal and metatarsal of an adult, the former being 55 mm. in length and 21 mm. in width at the middle of the shaft, while the latter is 59 mm. long (without the tarsals) and 19 mm. broad at the middle of the shaft; the proportions of these two bones are unlike those of any with which they have so far been compared. In some specimens, even when still immature, the distal row of the tarsals (cuboid, navicular, and cuneiform) are fused to the third and fourth metatarsals, as occurs in birds.

The Pleistocene mammalian fauna of an island almost always proves to be of great interest, and generally includes the remains of either primitive survivals related to a Tertiary fauna or forms specially adapted for existence in a restricted habitat, such as the pigmy races which occur in several of the Mediterranean Islands. The case of *M. balearicus* seems to be somewhat obscure; its goat-like cheek-teeth

are apparently highly specialized, although the present-day aspect of Majorca seems to afford no clue to causes sufficiently powerful to necessitate the peculiar modifications noted above. It is to be hoped that a further and more detailed study of these remains may throw more light on this interesting problem.

My thanks are due to Dr. C. W. Andrews, F.R.S., for his valuable assistance in comparing the above specimens with material in the British Museum (Nat. Hist.).

II.—On some Fossils from the Nubian Sandstone Series of Egypt.

By R. Bullen Newton, F.G.S.

(PLATES XX AND XXI.)

(*Concluded from the August Number, p.* 359.)

DESCRIPTION OF THE FOSSILS.

Group **PELECYPODA.**

Family **Unionidæ.**

Genus UNIO, Retzius (Philipsson).

Dissertatio Historico-Naturalis Nova Testaceorum Genera, 1788, p. 16.
Type = *Mya margaritifera*, Linnæus.

Synonyms—

Margaritana, Schumacher: Essai d'un nouveau Système des Habitations des Vers Testacés, 1817, p. 123, pl. x, fig. 4. Type = *Margaritana fluviatilis*, Schumacher = *Mya margaritifera*, Linnæus.

Alasmidonta, Say: Journ. Acad. Nat. Sci. Philadelphia, 1818, vol. i, p. 459. Type = *Unio undulata*, Say.

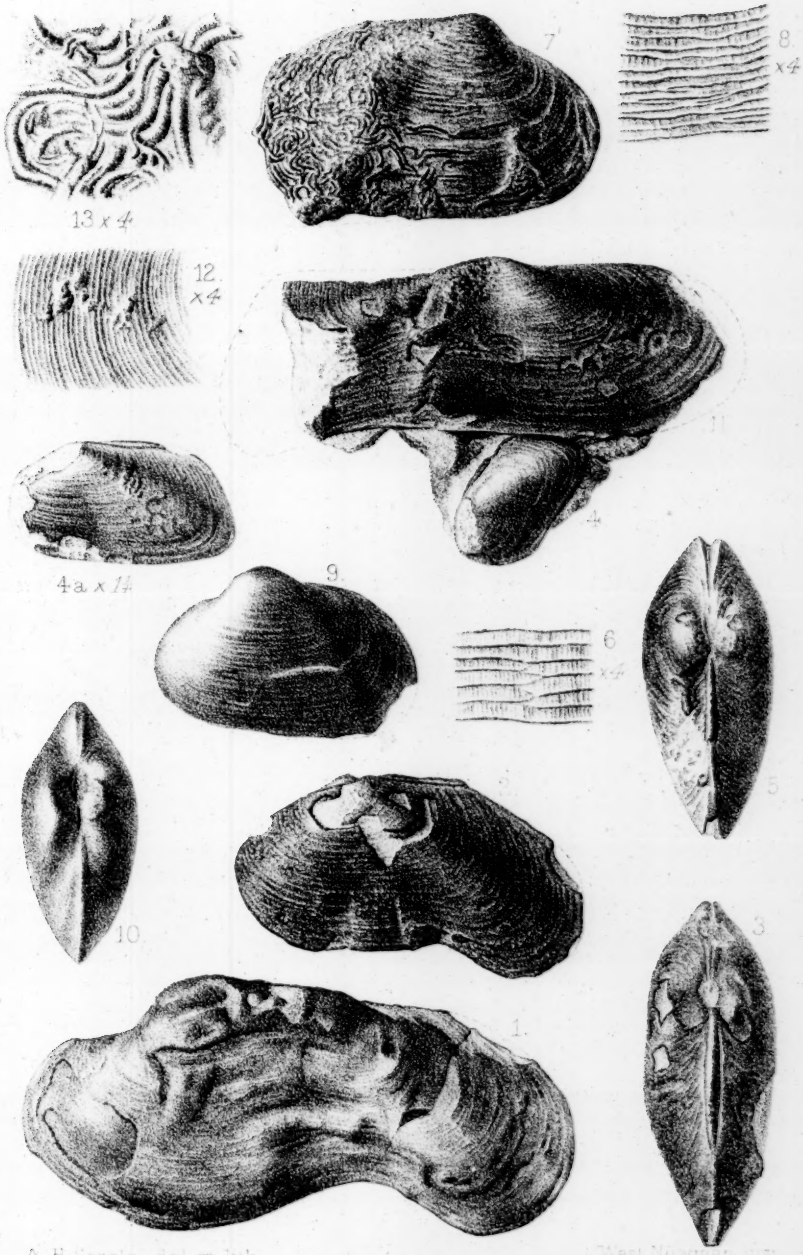
Unio Humei, sp. nov. (Pl. XX, Fig. 1.)

Description.—Specimen consisting of the natural cast of a left valve: form oblong, subtrigonal, mostly compressed; umbo anterior, depressed, incurved, succeeded in front by prominent lunuloid cavity; dorsal margin posteriorly elongate, oblique, continuous with the terminal curvature of margin; anterior region short, deep, slightly inflated on the ventral side of umbonal area; outer margin deeply excavated beneath the umbo, afterwards of oval contour; ventral margin anteriorly inflated, deeply sinuated in rear; posterior region furnished with an obtuse ridge directed obliquely from the umbo to the postero-ventral angle, on each side of which the valve slopes and becomes compressed; lateral face of valve between the anterior inflation and posterior ridge triangularly depressed; sculpture lines obscure.

Dimensions.—Height 35, length 75, diameter 12 mm.

Remarks.—This fossil, although mostly a cast, shows in places certain evidences of shell markings, but which are much too obscure for proper definition; rough lines of growth can also be traced. Its chief characteristics concern the presence of a lunulate area, the great depth of the anterior region being about 1½ times that of the posterior end, and the extensive, somewhat trigonal depression on the lateral face of the valve bordered below by the deeply sinuated margin. There are few forms of fossil Unionidæ which will bear comparison with the Egyptian specimen, although at first sight its affinities might be looked for among Wealden species. Messrs. Koch & Dunker[1] have described *Unio Menkei* from the Wealden deposits of Northern

[1] *Beiträge norddeutschen Oolithgebildes Versteinerungen*, 1837, p. 58, pl. vii, fig. 1.



A. H. Searle, del. et lith. West, Newman imp.

Nubian Sandstone Fossils
from Egypt

Germany which shows a slight basal sinuation, but differing greatly in other respects, such as in its contour lines, being of more equal height throughout, and having relatively shorter valves.

A further comparison with a Wealden species might also be made, as, for instance, with the well-known *Unio porrectus*, found chiefly in British localities and first described by J. de C. Sowerby,[1] the type being a transversely oval sandstone cast with fairly inflated valves, but possessing no basal sinuation, the ventral margin curving distinctly outwards. None of the Unionidæ of higher Cretaceous deposits appear to be in any way related to the present specimen.

Occurrence.—This fossil consists of a reddish-brown ironstone cast of a left valve isolated from the matrix. At the posterior extremity is a small portion of the opposing valve, but being somewhat obscure no details of importance can be cited in connexion therewith, except as illustrating complete compression of the valves in that area. An attempt has been made to develop the cardinal region, but without success.

UNIO JOWIKOLENSIS, sp. nov. (Pl. XX, Figs. 7–10.)

Description.—Shell (with closed valves) compressed, sub-oval; umbones anterior and eroded; dorsal margin horizontal, nearly parallel with ventral border; anterior region sloping from umbones, margins elliptically and moderately produced; posterior part obtusely ridged from umbones to postero-ventral corner, with prominent area sloping to rounded marginal extremity; lateral face sloping from umbonal region to basal margin, which is nearly parallel with dorsal line; sculpture showing nearly equidistant, fine, elevated, closely arranged, concentric striations with intermittent lineations.

Dimensions.—Height 30, length 47, diameter 18 mm.

Remarks.—The greater height and more compressed valves of this species removes it completely from its companion form *Unio Crosthwaitei*, although so far as ornamentation is concerned, and its possession of an obtuse postero-umbonal ridge, there is no doubt that both are allied species. This fossil presents a general resemblance to *Unio Menkei* of Koch & Dunker[2] from the Hanoverian Wealden, but differs in its finer ornamentation and the possession of a narrower and more produced anterior extremity. There is a second example of this species, of smaller size and with anteriorly eroded umbones, showing perhaps more plainly the postero-umbonal elevation and the lunuloid cavity. It is in a fair state of preservation, with the exception of the sculpture lines, which are not so distinct as in the larger specimen.

Occurrence.—The face of the right valve of the specimen described is largely covered with the tubes of the Annelid (*Galeolaria filiformis*), especially in the posterior region, otherwise the surface structure of the shell is well preserved. The left valve has been nearly all eroded away, showing the red-ironstone matrix and its microscopically fine pisolitic character.

UNIO CROSTHWAITEI, sp. nov. (Pl. XX, Figs. 2–6.)

Description.—Shell (with closed valves) sub-cylindrical, inflated; umbones anterior; dorsal margin nearly horizontal, arching posteriorly; ligament elevated, prominent, rounded, moderately thick, tapering in rear; anterior region short, no defined cavity

[1] *Mineral Conchology*, 1828, vol. vi, p. 189, pl. dxciv, fig. 1.

[2] *Beiträge norddeutschen Oolithgebildes Versteinerungen*, 1837, p. 58, pl. vii, fig. 1.

in front of umbones, margin rounded; posterior region obtusely ridged from umbo to postero-ventral angle, sloping and compressed behind; ventral area sinuated at margin; antero-central face of valves obliquely and somewhat triangularly compressed; sculpture consisting of fine, equidistant, concentric, elevated striations, sometimes wavy, bifurcating, and otherwise irregular, with obscure vertical ridging between; rounded, obscure plications of growth are also present.

Dimensions.—Height 25, length 47, diameter 18 mm.

Remarks.—The specimen described has closed valves, between which reposes a well-developed ligament tapering posteriorly and bearing a few obscure transverse constrictions. The eroded umbones and certain cavities present on both valves indicate the effects of past river action before final deposition. The ornamentation is extremely fine and well preserved, and without a lens appears fairly regular, but a closer inspection shows that filament lines are given off from the main concentric striations producing an appearance of bifurcation, these lines being often gently wavy. Comparing it with *Unio Humei*, the species has relatively more convex valves, a less prominent central depression, and a more cylindroid contour. This new form perhaps compares more readily with *Unio subsinuatus* of Koch & Dunker[1] from German Wealden deposits in possessing the ventral sinuation, although the valves are of greater depth, more convex, less rounded and full anteriorly, whilst the posterior extremity is more produced. Another example of the species, of somewhat shorter axis, possesses a well-preserved test with distinct and regular sculpture lines bearing intermittent vertical ridging; its umbones are a good deal eroded. What appears to be another form of this species is associated in the matrix with *Mutela mycetopoides*, together with fragmentary remains of the same shell standing out in relief on the weathered surface of the rock. This specimen exhibits a left lateral view of evidently a young form having a height of 13 and a length of 25 mm. The sculpture lines are extremely fine and numerous, the postero-umbonal ridge is prominent, and a slightly oblique, narrow furrow proceeds from the umbonal region to the ventral border, which may be of accidental occurrence and not structural. The specimen also shows that the umbo is eroded, and that there is little or no sinuation of the ventral margin.

Occurrence.—The specimens representing this species are in a good state of preservation, although, like the other freshwater shells of this collection, no internal characters are displayed. The matrix is of the same reddish-brown ironstone rock, exhibiting a minutely pisolitic structure, and the shells present a blackish metallic colour with a lighter weathering. On the postero-dorsal surface of the left valve of the principal specimen is an example of the *Galeolaria* situated in close proximity to the elevated ligament.

Genus MUTELA, Scopoli.

Introductio ad Historiam Naturalem sistens genera Lapidum, Plantarum, et Animalium, etc., 1777, p. 397 (No. 83).

Type = "Le Mutel", Adanson: Hist. Nat. Sénégal (Coquillages), 1757, p. 234, pl. xvii, fig. 21. (= *Iridina exotica*, Lamarck.)

Synonym—IRIDINA, Lamarck: Hist. Nat. Animaux sans Vertèbres, 1819, vol. vi, pt. i, pp. 88, 89. Type = *Iridina exotica*, Lamarck.

[1] *Beiträge norddeutschen Oolithgebildes Versteinerungen*, 1837, p. 58, pl. vii, fig. 2.

MUTELA MYCETOPOIDES, sp. nov. (Pl. XX, Figs. 11, 12.)

Description.—Shell (right valve) shallow, soleniform, narrow, sub-cylindrical, sub-arcuate, medially depressed; hinge line straight, linear, parallel with ventral border; umbo nearly central, small, compressed; anterior region obliquely inflated from the umbo, flattened in front, outer margin rounded and gaping; posterior part obliquely and obtusely ridged, having a sloping depressed area in rear; ventral margin concave; surface sculpture consisting of microscopically fine and close striations following the contour lines of the shell, being often irregular and sometimes of network character, and generally grouped within equidistant, rounded plications of growth.

Dimensions.—Height 25, length (approximate) 65, diameter (approximate) 10 mm.

Remarks.—The foregoing description is based upon an external view of a right valve attached to the rock, which, although of fragmentary character, being fractured posteriorly, still preserves some important features of the shell. Through compression and erosion the details of the umbo are not definite, but its almost median position seems to be clearly displayed. The opposing valve is in situ, as can be seen from the presence of the antero-ventral margin, the remainder being entirely hidden in matrix. These front terminal margins are important, since they exhibit the well-marked gape, which is seen to extend ventrally, as in the modern forms of this genus. On the central face of the valve, and near the ventral border, two small vertical depressions occur, produced probably by pressure or otherwise during the life of the mollusc, giving rise to constrictions which locally disturb the regularity of the lines of ornamentation. With regard to sculpture, the growth plications may be said to be fairly well developed in places, whilst the finer striations, only observable with a strong lens, are frequently intertwined and irregular, forming more or less a structure of filaments.

The principal characters of this specimen include the straight hinge line, the nearly median umbo, the posterior ridge, the inward curvature or sinuation of the central region of the valve, the sub-cylindrical contour, and anterior gape. In many of these details it appears to more nearly resemble *Mycetopus* of Orbigny[1] than Scopoli's *Mutela*, that is, judging from the type of the former genus (*M. soleniformis*), which lives in Central South American rivers; but remembering that *Mutela* belongs essentially to African freshwaters, and is moreover found in the alluvial deposits of the Nile,[2] it is more reasonable to suppose that the fossil under consideration represents an ancestral form of that genus rather than of another which belongs to a totally different continent. In order to mark this resemblance the present African fossil has been named *Mutela mycetopoides*.

Occurrence.—The fossil is adherent to a mass of ironstone matrix associated with a small form of *Unio* (*U. Crosthwaitei*). Its surface is mostly of a deep-black colour, besides being much cracked and perforated in places in consequence of erosive agencies. Quite a number of small, rounded, wart-like prominences are present on the fossil, these representing pisolitic grains of iron-ore, the presence of which would denote the highly ferruginous character of the waters

[1] *Voyage dans l'Amérique Meridionale*, 1846, vol. v, pt. iii, Mollusques, pp. 600, 601, pl. lxvi.

[2] Leith Adams, Quart. Journ. Geol. Soc., 1854, vol. xx, p. 15.

prevailing during the period of deposition. The matrix exhibits a light-coloured weathering on the exposed surfaces, and is of minutely oolitic structure.

Family **Aviculidæ**.

Genus INOCERAMUS, J. Parkinson.

Trans. Geol. Soc. [London], 1819, vol. v, pt. i, p. 55, pl. i, fig. 3.
Type = *Inoceramus Lamarcki*, Parkinson.

Inoceramus Balli, sp. nov. (Pl. XXI, Figs. 1–3.)

Inoceramus Cripsi, Blanckenhorn MS.: W. F. Hume, "Topography and Geology of the Peninsula of Sinai (south-eastern portion)," Survey Department, Egypt (Cairo), 1906, p. 153; John Ball, "Description of the First or Aswan Cataract of the Nile," Survey Department, Egypt (Cairo), 1907, p. 67. *Non* Mantell *nec* Goldfuss.

Description (specimen with closed valves).—Shell of moderately large size, equivalve, sub-quadrangular from the lateral aspect; valves antero-medially inflated, arched, compressed towards anterior margin, but considerably more so posteriorly and ventrally; cardinal line straight, horizontal, nearly equal in length to the height, longest posteriorly; posterior and ventral margins rounded, anterior, more or less truncated, sub-vertical; umbonal region antero-median, incurved, posteriorly inclined, but with probable anteriorly directed summits; surface of valves with about twenty elevated, prominent, rounded, concentric costæ with laterally attentuated ends, divided by furrows of corresponding width; costæ and grooves broaden as development proceeds, but become lost and insignificant in the area of greatest compression; extremely fine concentric lineations ornament the surface of the ridges and furrows.

Dimensions.—Height 120, length 115, diameter 75 mm.

Remarks.—This *Inoceramus* would appear to belong to the group of which *Cripsi* of Goldfuss (*non* Mantell)[1] might be taken as the type; in fact, the specimen has already been so determined by Dr. Blanckenhorn, although important differences exist which would undoubtedly separate it from the species itself. There is the rather quadrangular outline as opposed to the general transversely oval figure of the typical German shell, the presence of the prominent antero-median elevation from the umbonal part downwards, and the more medially situated umbonal area. Chiefly in the well-sculptured costæ and grooves does it approximate to the Goldfussian shell. The posterior inclination of the umbonal region, mentioned in the diagnosis, need not necessarily imply that the shell was opisthogyrous, as it is more than probable that were the summits in preservation they would be found assuming the usual anterior direction hitherto associated with the genus *Inoceramus*. A similar phenomenon may be observed in large examples of *I. concentricus*, Parkinson, of Albian (= Gault) age, which exhibit the prosogyrous character of the umbones followed by a more oblique

[1] Without attempting a revision of the Inoceramoid shells, it is necessary to remind the student that Orbigny was the first palæontologist to recognize the importance of separating into two species the forms which Goldfuss had included under *Cripsi* in the *Petrefacta Germaniæ*. He therefore substituted *Goldfussianus* for *Cripsi*, because the latter name was preoccupied by Mantell for a shell of different form and horizon (Cenomanian), limiting its application to the example represented by fig. 4*d* of the Goldfuss plate 112; whilst that of *regularis* was acknowledged to embrace figs. 4*a*, *b*, *c* of the same plate (see Orbigny, *Pal. Française Terr. Crétacés Lamellibranchia*, 1845, p. 517, pl. cccexi, and *Prodrome Pal. Strat.*, 1850, vol. ii, p. 250). The nomenclature of some of these Senonian Inocerami has been recently under the consideration of Dr. Joh. Böhm in the *Monatsber. Deutsch. Geol. Ges.*, 1907, No. iv, p. 113.

A. H. Searle, del. et lith. West, Newman imp.

Inoceramus Balli sp. nov.
from the Nubian Sandstone of Egypt.

arrangement of the ridges and grooves anteriorly than on the opposing side, and so producing a posterior curvature of the umbonal region. In its actual marginal contour, judging from the lateral aspect, it follows very much the lines of Zittel's *I. Cripsi*, var. *typica*, a Gosau species of Campanian age (Denksch. k. Akad. Wiss. Math. Nat., 1866, vol. xxv, p. 98, pl. xiv, fig. 1), though not so rounded anteriorly where the costæ are more or less vertically disposed, especially on the right valve. Again, the umbonal region of the Gosau shell is much nearer the anterior margin, besides exhibiting a strong anterior obliquity; the costæ are also more numerous, and the valves have not the prominently arched feature of the specimen from Egypt. In general form, therefore, and sculpture characters the specimen favours an Upper Cretaceous horizon, and it may reasonably be regarded as Senonian; in fact, it is more than possible that its real place in the series would be the Campanian stage of that period, as specified on Blanckenhorn's manuscript label accompanying the specimen, because it is in that stage the so-called *Cripsi* and its allies are more generally found in the world's Cretaceous regions, such as the United States, India, Japan, etc.

Occurrence.—The only specimen available is in a good state of preservation with both valves in the closed position, shell structure being seen in places with the delicate surface lineations. The margins are rather imperfect, especially on the left anterior side, where there is evidence of crushing, which was probably effected during the process of fossilization. Since its arrival from Egypt a large part of the matrix of the left valve has been skilfully removed by Mr. Richard Hall, the senior Formatore of the British Museum (Natural History), thus exposing the centrally arched elevation and the extensive areas of depression at the base and rear. Through mineralization and wind erosion the right valve has to a great extent lost the surface and ornamentation of the umbonal region, but all its later characters are well displayed. The matrix is highly ferruginous and of limonite character, being mostly of a reddish-brick colour. Where wind erosion has taken place through long exposure, the surface of the valves is quite lustrous and polished and of a blackish-brown metallic appearance. There are some obscure remains of Annelid tubes on this specimen which from their fineness might probably be referred to *Galeolaria filiformis*. In a recent letter Dr. John Ball kindly furnished the following particulars as to the locality where he was fortunate enough to discover this unique *Inoceramus*:—"It was obtained from near the west-end of the Aswan dam, on the west bank of the Nile, during excavations for a small reservoir, and, as far as I remember, it was quite low down in the local series not more than 20 metres above the old igneous rocks. From the adherent matter you will see it came from one of the more ferruginous beds in the sandstone." Soon after this information was sent, Dr. Ball, then on vacation in England, called at the British Museum and supplied some further details as to the occurrence of the genus in this part of Egypt. He had subsequently found fragments of another *Inoceramus*, of what might be the same species, near the triangulation station of Abajaj, which is about 17 kilometres E.N.E. of Aswan on the east bank of the Nile, in

a similar ferruginous rock at about 120 metres above the Nile. Unfortunately this later material is in the Survey Museum at Cairo, and not available at the present moment for comparison with the Aswan specimen.

Group **ANNELIDA**.

Family **Serpulidæ**.

Genus GALEOLARIA, Lamarck.

Hist. Nat. Anim. sans Vertèbres, 1818, vol. v, p. 371.

GALEOLARIA FILIFORMIS, J. de C. Sowerby. (Pl. XX, Fig. 13.)

Serpula filiformis, J. de C. Sowerby: Trans. Geol. Soc. London, 1836, ser. II, vol. iv, pt. ii, p. 340, pl. xvi, fig. 2.

Galeolaria (*Serpula*) *filiformis*, Bronn: Handbuch Geschichte Natur., 1848, vol. i, p. 521.

Serpula filiformis, Stoliczka: Palæontologia Indica, 1873, vol. iv, pt. iv, p. 63, pl. xii, fig. 6; Kossmat, "Cretaceous Deposits of Pondicherri," Records Geol. Surv. India, 1897, vol. xxx, pp. 96, 107, pl. x, fig. 7 (translated from the German).

Serpula (*Galeolaria*) *filiformis*, R. B. Newton: Ball & Beadnell's Report, "Baharia Oasis," Survey Dept. Public Works Ministry, Egypt, 1903, p. 55.

Remarks.—The original account states that this species consists of "smooth, round tubes, slightly curved, and aggregated into elongated, often branching masses. The tubes are rather thick, nearly equal throughout their substance". Although not so entirely fasciculate as is usual with this species, the form from the Nubian Sandstone shares most of the characters as indicated in the first description. It is found adherent to the valves of the unioniform shells (especially to *Unio Jowikolensis*), the tubes curving and intertwining in various directions, and sometimes lying side by side in parallel curvatures more or less contiguous, whilst the posterior ends are occasionally acuminate. The tubes are quite small, barely half a millimetre in diameter, and without the aid of a lens present an almost filamentous appearance. Some obscure indications of transverse striations appear to be perceptible, but this is very uncertain, as the surface shows evidence of erosion, making it difficult to say whether it was not originally polished and smooth as in ordinary examples of this species. The more isolated of the tubes are observed to run parallel with the sculpture lines of the valve. The species was first described from the Blackdown Beds of England, now regarded as of Albian age, the same massive fasciculate type having in more modern years been recorded from the Upper Cretaceous rocks of Africa and India, both Stoliczka and Kossmat having recognized it in the Arialyur Group of Southern India (= Senonian), whilst Messrs. Ball & Beadnell collected it in a ferruginous, sandy looking, more or less calcareous rock of Cenomanian age occurring in the Baharian region of the Libyan Desert of Egypt, associated with other true marine fossils such as *Exogyra Olisiponensis*, etc. Good examples of the species have been figured by Pictet & Renevier[1] from the Aptian deposits of Switzerland, so that its geological range appears to extend almost throughout the Cretaceous Series. It is also mentioned by Stoliczka as occurring in

[1] Descr. Foss. Terr. Aptien St. Croix—Matériaux Pal. Suisse, 1854, pt. i, p. 17, pl. i, figs. 10–15.

the Cenomanian, Turonian, Senonian, Quadersandstein, and Pläner of England, France, Germany, and Austria.

Closely allied forms are Dujardin's[1] *Serpula filosa* from the French Cenomanian-Turonian Series (Touraine district), which has exceedingly fine tubes and is also of fasciculate habit, and *Serpula plexus*, J. de C. Sowerby,[2] from British Senonian rocks. It would therefore appear that this particular type of Annelid being fairly representative of Upper Cretaceous rocks, we may assume that the Nubian Sandstone specimen belongs to that part of the Cretaceous system. Following Bronn, the species is included in Lamarck's genus *Galeolaria*, and it is so determined in the British Museum.

Occurrence.—This fossil forms one of those rather rare instances of a marine organism being found in direct association with another of freshwater character, proving that marine conditions prevailed and were in fairly close proximity to the river agencies which had brought down the fluviatile shells to the area where deposition was in progress. A similar combination of organisms may be mentioned in connexion with a piece of limestone of the 'Munder Mergel' Series of North Germany, regarded as the base of the Wealden (=Purbeckian), which exhibits a small form of *Cyrena* in company with *Serpula coarcervata*, Blumenbach, the specimen being in the British Museum with the registered number A–64.

Conclusions.

From a glance at the list of fossils already known to occur in the Nubian Sandstone of Southern Egypt (see p. 358), it will be seen that the formation is of considerable depth in places, and especially in the Wadi Kena, where Figari Bey (according to Zittel) obtained *Mosasaurus* remains at a depth of 400 feet. This Vertebrate belongs chiefly to the uppermost part of the Senonian (Mæstrichtian), although Blanckenhorn regards the Egyptian occurrence as of older Senonian (Santonian) age. From a boring in the neighbourhood of Edfu at a depth of 308 feet, Coquand reported the finding of *Ostrea Verneuili*, which he considered to be of Garumnian age, a member of the Danian; and later Dr. Hume discovered numerous *Lingulæ* and *Mytilus* cf. *lineatus*, etc., in a well boring at Abu Rahal, 164 feet from the surface, which he stated were of Cretaceous age.

The silicified woods (*Araucarioxylon* and *Nicolia*) of this formation and the fern remains described by Professor Seward indicate its estuarine origin, that is so far as Southern Egypt and Nubia are concerned.

A study of the present fossils supports the Cretaceous view as to the age of this part of the Nubian Sandstone, which, it is interesting to observe, was initiated some seventy years ago by Lefévre after an examination of the rocks as exposed at Aswan.

In speaking of the freshwater shells, which appear to be the only mollusca of that character recorded from the Nubian Sandstone since Russegger's discovery of *Cyclas faba*? of Münster in 1843 from near Aswan, they appear at first sight to bear a relation to Wealden forms,

[1] Mém. Soc. Géol. France, 1835, vol. ii, pt. i, p. 233, pl. xvii, fig. 18.
[2] *Mineral Conchology*, 1829, vol. vi, p. 201, pl. dxcviii, fig. 1.

but when carefully examined such resemblance is not maintained, nor do they compare with any closeness to similar shells found in the later deposits of the Cretaceous Series. Russegger regarded his *Cyclas faba*? as indicating Greensand, Quadersandstein, or Wealden, but as the specimen was never figured or described, its scientific value at the present day is unimportant. It may be mentioned, however, that none of the unioniform shells now described could possibly be mistaken for the genus *Cyclas*.

The fact that a marine organism accompanies the shells appears to be ample testimony of the estuarine conditions which prevailed during the deposition of the beds, as doubtless the valves, probably in the dead state, were brought along by river action to the neighbourhood of the sea, and so became associated with marine life.

So far as the Annelid tubes are concerned, their determination as *Galeolaria filiformis* appears to be correct, and although this is a species which ranges throughout the Cretaceous system, it is satisfactory to learn of its occurrence in the Arialyur Group (= Senonian) of India, and in the rocks of the Baharia Oasis of the Libyan Desert of Egypt accompanying Cenomanian mollusca (*Exogyra Olisiponensis*, etc.).

The *Inoceramus*, as pointed out, belongs to a group of forms which are restricted to Upper Cretaceous rocks, and mostly to the Campanian stage of the Senonian period. Paul Choffat[1] records *I. Cripsi*, var. *typica*, of Zittel as having been found in a sandstone outlier at Mira in Portugal associated with *Hoplites Vari*, var. *Marroti*, of Coquand, and determined as of Campanian age. Fournel's[2] *Cripsi* (= *regularis*, Orbigny) is found in the Senonian of Algeria.

According to Madagascar[3] lists *Cripsi* (Goldfuss) occurs in that country, and is regarded as Senonian. Both Stoliczka[4] and Kossmat[5] recognize the same form in the Upper Senonian of Southern India, as also does Professor Yokoyama[6] in the Senonian of Japan. Further, Whiteaves[7] has recognized it in the Senonian of Vancouver, whilst under the names of *Sagensis* of Owen and *Barabini* of Morton, Whitfield[8] has identified it among the fossils of the Raritan Clays, etc., of New Jersey, United States.

When it is considered that the typical form of *Inoceramus* of Turonian times is the *labiatus* of Schlotheim, and that the true *Cripsi* of Mantell belongs to the Cenomanian, there seems little doubt that the new species now described, with a facies peculiarly Senonian, might accurately be relegated to that period and possibly to its Campanian stage.

Although a distance of some 25 miles separates the localities from

[1] Recueil de Monographies Stratigraphiques systeme Crétacique du Portugal, pt. ii, Le Crétacique Supérieur au Nord du Tage, 1900, p. 228.
[2] Richesse Minérale de l'Algérie, 1849, vol. i, p. 370, pl. xviii, figs. 31, 32.
[3] Lemoine, *Etudes Geologiques dans le Nord de Madagascar*, 1906, pp. 222, 250.
[4] Mem. Geol. Surv. India, Pal. Indica, 1871, p. 405, pl. xxvii, fig. 3.
[5] Records Geol. Surv. India, 1897, vol. xxx, p. 82 (correlation table).
[6] Palæontographica, 1890, vol. xxxvi, p. 175, pl. xviii, figs. 6, 7.
[7] Geol. Surv. Canada, 1879, pp. 170–3.
[8] Mon. United States Geol. Surv., 1885, vol. ix, pp. 75–9, pl. xiv, figs. 15, 16, and pl. xv, figs. 3–5.

which these fossils were obtained, the lithological nature of the matrix is identical in both areas, and may therefore be regarded as of similar age, so that the fauna of the Jowikol Beds exhibiting fresh-water and marine characters is consequently of estuarine origin, and, moreover, may be determined as of Senonian horizon.

EXPLANATION OF PLATES.

Plate XIX.

Topographical sketch-map of Egypt, showing localities of Nubian Sandstone Fossils, from the original designed by Dr. John Ball (see *ante*, p. 353).

Plate XX.

Unio Humei, sp. nov.

FIG.

1. Left lateral view of specimen.

Unio Crosthwaitei, sp. nov.

2. Left lateral aspect.
3. Dorsal view of same, showing ligament and eroded umbones.
4. Younger form of probably the same species, associated with *Mutela mycetopoides*.

4*a*. An enlarged view of the same specimen. × $1\frac{1}{4}$.

5. Dorsal view of another specimen with ligament, and valves slightly open at the ends.
6. Surface structure of same, showing concentric lineations, sometimes bifurcating, and transverse ridging. × 4.

Unio Jowikolensis, sp. nov.

7. Right lateral view of specimen, with adherent Annelid tubes.
8. Surface structure of same, showing irregular lineations with transverse ridges between. × 4.
9. Smaller specimen of the same species, left lateral aspect.
10. Dorsal view of same, showing eroded umbones.

Mutela mycetopoides, sp. nov.

11. Right lateral aspect of specimen on matrix, associated with a probably young form of *Unio Crosthwaitei*.
12. Magnified view of surface structure in the postero-dorsal region. × 4.

Galeolaria filiformis, J. de C. Sowerby.

13. Portion of the colony adherent to the valve of *Unio Jowikolensis*. × 4.

The above specimens were obtained from Jowikol, on the east bank of the Nile, between Kalabsha and Aswan.

Plate XXI.

Inoceramus Balli, sp. nov.

1. Left lateral view of specimen slightly reduced in size. × $\frac{2}{3}$. Showing the prominent costæ and compressed regions.
2. Dorsal view of same, exhibiting the elevated and arched character of the umbonal region and its inclination posteriorly. × $\frac{2}{3}$.
3. Surface structure, showing the fine lineations on the costæ and grooves—a restored figure. × 4.

This specimen was from the west end of the Aswan Dam.

Note.—Unless mentioned to the contrary, the figures on Plates XX and XXI are represented of the natural size. The specimens belong to the Museum of the Geological Survey of Egypt.

III.—Notes on new or imperfectly known Chalk Bryozoa (Polyzoa).

By R. M. Brydone, F.G.S.

(*Continued from p.* 339.)

(PLATES XXII AND XXIII.)

Membraniporella monastica, nov. Pl. XXII, Figs. 1–3.

Zoarium always encrusting.

Zoœcia pyriform, average length and breadth ·43 mm. and ·28 mm.; aperture semicircular, with a small tubercle at each side; front wall normally formed of five pairs of spines, the space between the lowest pair being filled by a triangular plate perforated at the apex and possibly tubular, as when it is broken off its base proves to be perforated; when there is a preceding zoœcium with an oœcium the fifth pair of spines and the triangular plate disappear, and the space so left is filled by the preceding oœcium, which always carries a small avicularium, possibly a relic of the triangular plate; the spines are not always strictly paired; the backbone is often depressed and pierced by irregular pores.

Oœcia subquadrate, expanded above, free edge nearly straight.

Avicularia. Besides the small avicularia on the oœcia there are many independent avicularia scattered irregularly between the zoœcia; they are long, narrow, and tumid, with triangular apertures, and resemble a monk's cowl.

The front wall is very fragile, and slight attrition will turn a specimen into a spinose *Membranipora*, but the avicularia and oœcia will still enable its true nature to be recognized.

Abundant at Trimmingham.

Membraniporella castrum, nov. Pl. XXII, Figs. 4 and 5.

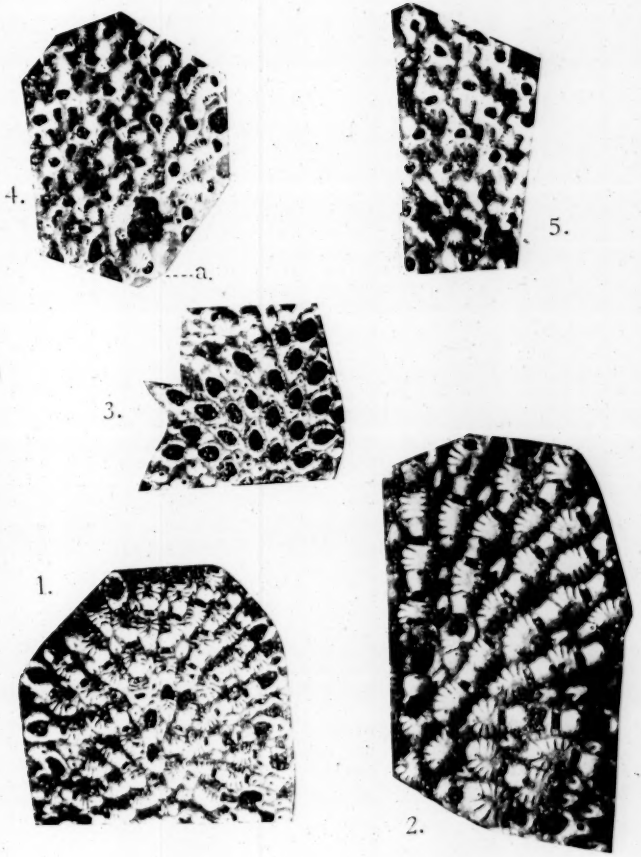
Zoarium always encrusting.

Zoœcia deeply sunk inside an embankment of secondary structures, average length and breadth ·58 mm. and ·33 mm. The primary form appears to be shown in Fig. 4, at *a*, as slightly pyriform with a semicircular aperture and a front wall composed of from 13 to 16 radiating and more or less paired spines, the first pair thickened and bearing a stout triangular tooth projecting into the aperture. In the mature form the walls and the lower lip of the aperture are strongly elevated and tiny mandibular avicularia appear at the corners of the aperture, and these structures blend with one another and the similar structures of adjoining zoœcia to form a large secondary aperture of irregular shape and high enclosing wall round the front wall. From a depression in the middle of the lower side of the lower lip of the secondary aperture a broad bar with a median furrow descends gradually to the front wall.

Oœcia large, globose, projecting through the margin of the secondary aperture, within which their free edges are sometimes visible.

Avicularia. Besides the pair normally present at the corners of the aperture, similar avicularia occur occasionally on the walls and round the aperture.

Fairly common at Trimmingham.



R. M. Brydone phot.

Chalk Bryozoa (Polyzoa).

Cribrilina ostreicola, nov. Pl. XXIII, Figs. 1 and 2.

Zoarium always encrusting.

Zoœcia pyriform, average length and breadth ·45 mm. and ·28 mm.; aperture semicircular, lower lip often curved slightly outwards; front wall composed of from 13 to 15 spines more or less arranged in opposing pairs and separated by furrows with a large pore at the outer end and otherwise finely punctate.

Oœcium large, globose, the free edge corresponding in outline with but slightly smaller than the upper lip of the aperture.

Avicularia very numerous and of three classes, all of duller texture than the zoœcia. The most abundant are small and slender, with a strong inflation of the upper end, in which a slit-like aperture is set, and lie in almost continuous lines between the lines of zoœcia. The second class are mandibular, of regular occurrence, and often vicarious, with a central oval aperture surrounded by a slender ring, and a rounded symmetrical beak. The third class (possibly vibracularia) occur very irregularly and are large and quadrangular, with a relatively very small oval aperture rather above the centre.

Very abundant at Trimmingham, mainly on *Ostreæ*.

Cribrilina subvitrea, nov. Pl. XXIII, Figs. 3 and 4.

Zoarium always encrusting.

Zoœcia small, average length and breadth ·45 mm. and ·28 mm.; aperture transversely oval, with a deep subtriangular slit in the lower lip; front wall tumid, with many imperforate radiating furrows too faint to be accurately counted.

Oœcia tumid, elongated, subtriangular, very faintly keeled and transversely furrowed, free edge corresponding in outline with but smaller than the upper lip of the aperture.

Avicularia of two classes. The first class small, narrow, pointed, with oval apertures, usually in pairs like horns at the head of the zoœcium, very constant. The second class (possibly vibracularia) are vicarious, polygonal, with very small central circular apertures, occurring irregularly and often in bands and groups.

These vicarious avicularia and some of the zoœcia are depressed below the general surface, and have a dull appearance like that of roughened glass. The dull zoœcia show the radiating furrows much better than the normal ones.

This species is very closely related to the form identified by Beissel[1] with *Cellepora elegantula*, Hag., undoubtedly in error, but is easily distinguishable by its imperforate surface and vicarious avicularia. Marsson[2] has referred Beissel's form to *Schizoporella cornuta*, Hag. sp., but it is clearly a strict *Cribrilina*, and being unnamed may be called *Cribrilina Beisseli*. *C. subvitrea* is technically a *Schizoporella*, but its close relationship to *C. Beisseli* makes me feel justified in regarding its furrows as genetic and classifying it as a *Cribrilina* until the time comes for the Cribrilinidæ to be dismembered.

Abundant at Trimmingham.

[1] *Über die Bryozoen der Aachner Kreidebildung*, Haarlem, 1865, p. 60.

[2] Op. cit.

Homalostega cuniformis, mihi. Pl. XXIII, Figs. *5a–d*.

A specimen with oœcia occurred when there was still time to revise the original diagnosis (*ante*, p. 338) that no oœcia were known, but it was too late to add to Pl. XIV, Figs. 6 and 7. I now give figures of some oœcia, the one figured as *5b* being probably perfect.

EXPLANATION OF PLATES XXII AND XXIII.

Plate XXII.

Fig. 1. *Membraniporella monastica*. × 20.
,, 2. Ditto, part of same specimen. × 40.
,, 3. Ditto, part of worn specimen. × 20.
,, 4. *Membraniporella castrum*. × 20.
,, 5. Ditto, another specimen. × 20.

Plate XXIII.

,, 1. *Cribrilina ostreicola*. × 20.
,, 2. Ditto, another specimen. × 40.
,, 3. *Cribrilina subcitrea*. × 20.
,, 4. Ditto, part of same specimen. × 40.
,, *5a–d*. *Homalostega cuniformis*.

(*To be continued.*)

IV.—On the Skull of *Tapinocephalus*.

By Professor R. Broom, M.D., D.Sc., For.Corr.Z.S.Lond., Victoria College, Stellenbosch, Cape Colony, South Africa.

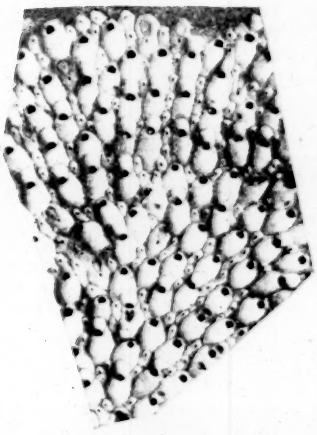
(with two text-figures.)

In 1876 Owen described the tip of the snout of a large fossil reptile from South Africa under the name of *Tapinocephalus atherstoni*. Although a few vertebræ and other bones of the skeleton are known, as no further remains of the skull have been found we have been in complete ignorance of the affinities of this one of our largest Karroo reptiles.

In the Seeley Collection in the British Museum there is a nearly perfect but somewhat crushed skull which pretty certainly belongs to the genus *Tapinocephalus* and, although it is about one-third smaller, perhaps to the type species. Another specimen shows the postorbital portion of the skull. To these specimens Dr. Smith Woodward has called my attention, and very kindly given me permission to describe them.

The skull consists of a broad, high, rounded posterior portion and a broad, flat snout. The orbit is near the middle of the skull, and there is on each side a single temporal opening, and the quadrate is carried well forward and lies under the postorbital arch. The general structure will, however, be better understood from the figures given. Fig. 1 represents a side view of the skull slightly restored, and with the distortion corrected. Many of the sutures are obscured, but sufficient can be made out to leave no doubt as to the nature of the skull. The temporal arch is essentially similar to that in the Therocephalians and Anomodonts, being formed entirely by the squamosal and the jugal, both of which are very large. The quadrate is also large, but mainly hidden by the squamosal. Owing to the advanced position of the quadrate the lower jaw must have been short, its

1.



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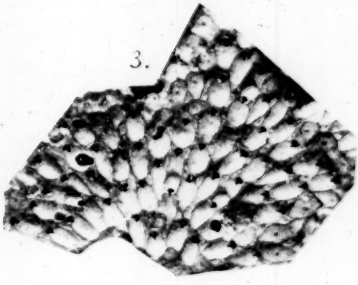

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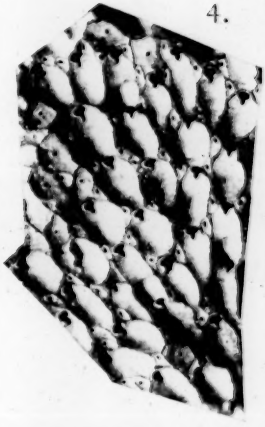

5.

R. M. Bruckner phot.

Chalk Bryozoa (Polyzoa).

probable shape being represented by the dotted lines. Fig. 2 represents the under side of the skull, and shows a most interesting condition of the palate. Between the large internal nares are a pair of prevomers, and behind and to the outer side of the nares a pair of small palatines. The pterygoids are large, and in front meet the prevomers. Externally they form large descending processes along the inner sides of the mandibles. There are no teeth on the palate, and there appears to be no transpalatine.

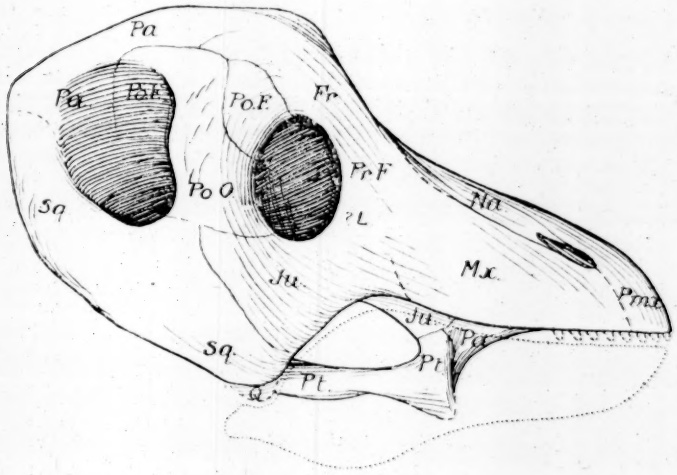

FIG. 1. Profile of skull of *Tapinocephalus atherstoni*, Owen: Karroo formation, S. Africa (greatly reduced).

The occiput is very large and slopes upwards and backwards. In general structure it appears to resemble that of *Dicynodon*, but it is not well preserved in either specimen. The condyle is large and rounded and the foramen magnum small. There is a very large exoccipital which meets the descending squamosal and also the quadrate. As in *Dicynodon* there appears to be an ossified tympanic. As preserved the skull measures 500 mm. in length, but if uncrushed would probably be about 30 mm. more.

Of skulls hitherto described the only one closely allied to that of *Tapinocephalus* is *Delphinognathus*. Though *Tapinocephalus* differs from *Delphinognathus* in having a very feeble dentition, there is little doubt it should be placed in the same sub-order, Dinocephalia of Seeley.

The Dinocephalians have relations with both the Therocephalians and the Anomodonts. In the structure of the palate they come nearest to the Therocephalians, but in most other respects the affinities appear to be nearer *Dicynodon* and its allies. Most probably they are an offshoot from an early Therocephalian closely related to that which started another line of descent and gave rise to the Anomodonts.

Though the locality of Seeley's specimen is unknown, there can be little doubt it is from the *Pareiasaurus* zone of the Gouph.

In examining Owen's type in the light of this new skull it becomes

manifest that two of Owen's identifications are wrong. The two bones internal to the nares which he regarded as nasals are the nasal processes of the premaxillaries, and the two bones which form the nasal floor and lie between the prevomers ('vomers') and the

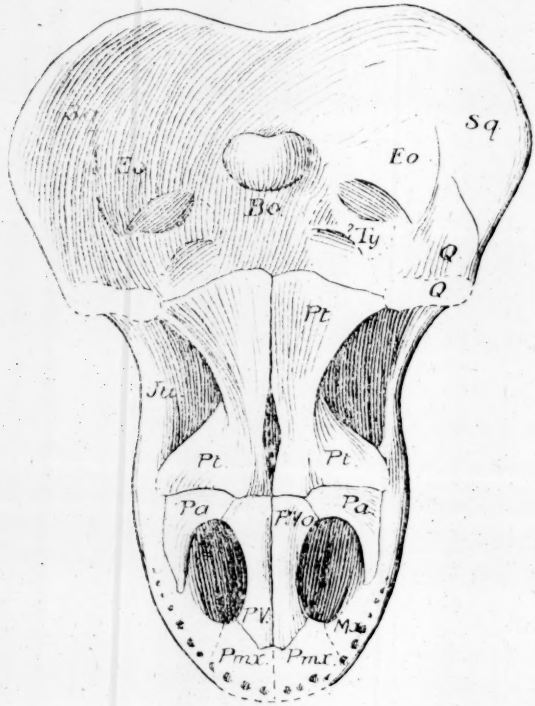

Fig. 2. Palatal aspect of skull of *Tapinocephalus atherstoni*, Owen: Karroo formation, S. Africa (greatly reduced).

maxillaries, and which were regarded as palatines by Owen, are apparently septomaxillaries. This presence of septomaxillaries is very interesting, as they appear to occur in *Pareiasaurus* and are present in Therocephalians, Cynodonts, and Monotremes, but are absent from Anomodonts.

V.—Note on the Association of Cassiterite and Specular Iron in the Lodes of Dartmoor.[1]

By Donald A. MacAlister, Assoc.R.S.M., F.G.S.

(with four text-figures.)

SITUATED in the neighbourhood of Birch Tor, in the heart of the granite mass of Dartmoor, at an elevation of between 1300 and 1400 feet, there are a number of tin-mines which have been worked

[1] Communicated by permission of the Director of the Geological Survey.

fitfully from remote periods (Fig. 1). The region is wild and lonely, and has in a marked degree all the scenic peculiarities of the moorland districts of the west of England.

The area over which mining has been carried on is about 1½ square miles, and is readily distinguished from the surrounding country by the numerous immense open-cuts or gullies (loc. 'gunnies') which have been made in it along the 'backs' or outcrops of the more important lodes; while the heaps of veinstone debris and mine refuse in the valleys combine to make it a picture of desolation.

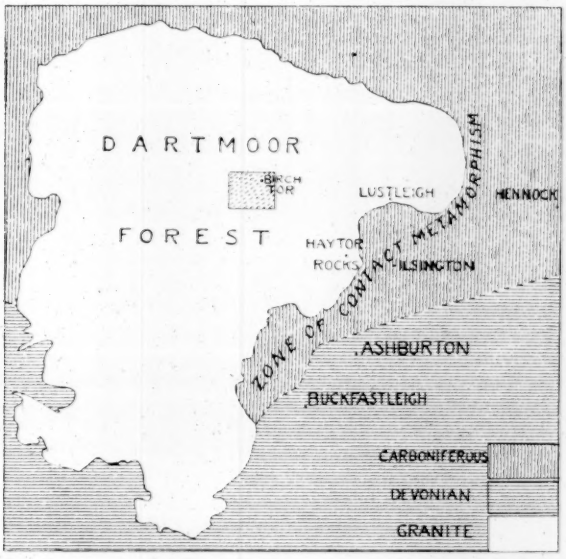

FIG. 1. Key-Map showing position of Birch Tor, Haytor, and other places mentioned in the text.

The ordinary granite of the district is coarsely porphyritic and contains well-formed crystals of dark mica. Tourmaline is a common accessory mineral, and occurs as individual crystals or stellate patches, or as nests of schorl-rock.

In the lode area the ordinary granite has been invaded by a multitude of dykes of granophyre, fine-grained granite, and elvan, which are so poorly exposed as to be unmappable, but the extent of their distribution is indicated in the figure by the shading (Fig. 2).

The principal mines are the 'Birch Tor and Vitifer' and the 'Golden Dagger', and these are, at the present time, only working in a small way. Wheal Catherine, Bushdown Tin-mine, and numerous other small mines have long since been abandoned.

The following table of the total yield of tin-ore from the mines during the periods for which statistics are procurable will best indicate the scale upon which they have been worked:—

Mine.	Dressed 'Black-Tin'.	Period of Working.	Remarks.
	Tons.		
Birch Tor and Vitifer.	670	From 1852 to 1865; 1872 to 1882; 1887 to 1890; 1903 to 1907.	In 1882 the metal contained in the Black-tin amounted to 64 per cent.
Golden Dagger.	170	From 1882 to 1906.	In 1882 the metal contained in the Black-tin amounted to 55 per cent.
New Birch Tor.	394	From 1859 to 1874.	

The lodes depicted in the illustration have been mapped on the spot from such evidence as is afforded by open-cuts, lines of trial pits,

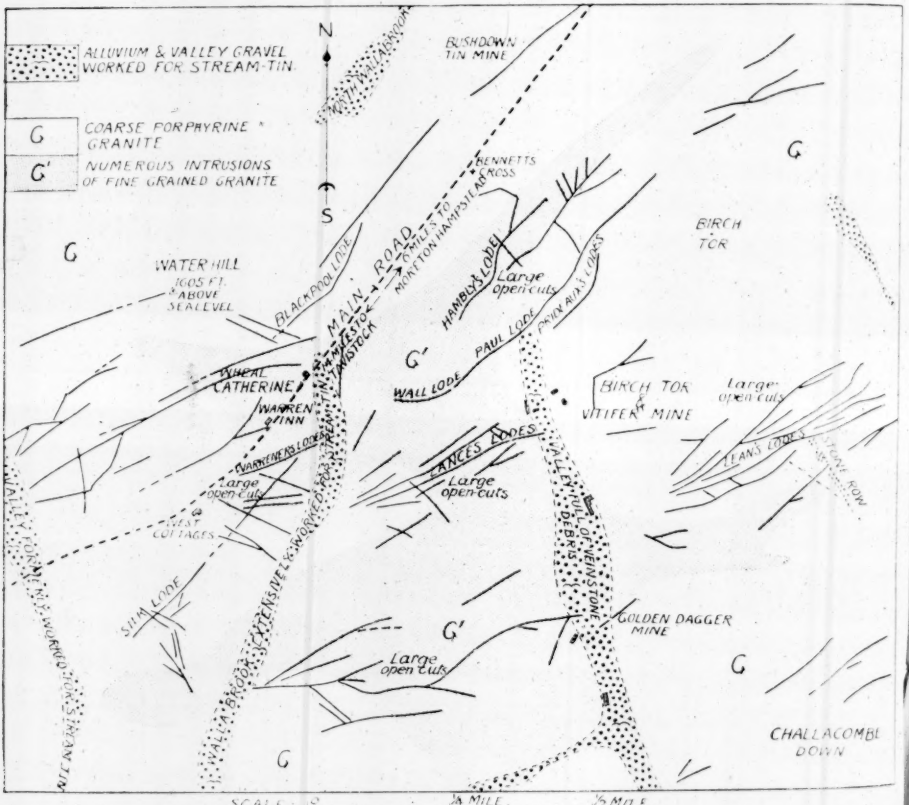

Fig. 2. Geological Map of the Birch Tor Mining District, Dartmoor.

* *Coarse Porphyrine* should read *Coarse Porphyritic*.

or other artificial excavations, and the names given to them are those by which they are known locally. Their general bearing ranges between E. 25° N. and E. 45° N.

The lodes are simply more or less vertical fissures filled with gangue or veinstone showing no signs of brecciation. In width they vary from that of a mere rift or crack up to 2 feet or more. In many of the open-cuts it will be seen that much of the material worked away is a rotted, somewhat kaolinized granite traversed by innumerable minute vertical fissures crossed by mineralized horizontal pseudo-bedding planes of the granite. In other cases (e.g. Lean's Lodes) massive siliceous veins occupy fissures of considerable width.

The special interest in these lodes lies in the intimate association of the cassiterite with specular iron-ore, and in this connexion Lean's Lodes, which, by means of an adit level, have been worked for 200 fathoms eastwards from the valley, are particularly good examples.

The veinstone consists of massive quartz with streaks and nests of fine acicular blue tourmaline.

The tinstone and specular iron-ore occur intimately mingled with one another or as separate veins, and are, in both cases, frequently accompanied by much fine tourmaline. Chalcopyrite and mispickel are absent, and with the exception of a little iron pyrites, which occurs sporadically here and there, sulphides do not occur.

A chemical examination of the specular iron-ore, which has the form of small, brilliant spangles, proved it to be quite free from titaniferous minerals.

The structure of the veins as a whole does not reveal any evidence that there was a definite sequence in the order of deposition of the minerals, which may therefore be regarded as contemporaneous. Fig. 3 is a diagrammatic sketch of a thin slice of the ore as seen through the microscope. The minerals depicted are quartz, cassiterite, specular iron-ore, tourmaline, and a little mica. The cassiterite occurs as granular aggregates or as well-formed prisms, which are often long and slender. The specular iron-ore shows opaque lath-shaped sections, and occurs in close association with the cassiterite, but is never enclosed by the latter. The study of its relationship with the cassiterite indicates that it crystallized after the latter, for it sometimes occurs interstitially or appears to have partly crystallized round the cassiterite. It has a closer connexion with the tourmaline, which bears, as a whole, a similar relationship towards the cassiterite. The tourmaline has the form of fine dull-blue needles or fibres radiating from a point or scattered through quartz. It also occurs as zoned prisms with acicular fringes at the ends. The mica is of rare occurrence, and is seen only in minute aggregates, as indicated by the letter *M* in the figure. All these minerals are embedded in quartz of one generation. Under crossed nicols the latter has the appearance of a coarse mosaic. It contains numerous inclusions of slender tourmaline needles and fluid cavities with bubbles. The sequence of crystallization appears to have been (1) cassiterite, (2) specular iron-ore and tourmaline, (3) quartz.

The actual proportion of cassiterite in the material mined I could

not ascertain, but, on the assumption that it is 2 per cent., the amount of specular iron present must, at the lowest computation, be well over 8 per cent., since for every ton of dressed Black-tin obtained nearly 4 tons of specular iron have been removed by a magnetic separator, and a still greater amount has been washed off in the processes the material subsequently undergoes. It would be safe to say that the lode contains about 20 per cent. of iron-ore.

The employment of the magnetic separator is merely to free the tinstone from the iron-ore, and, with the exception of 25 tons of specular iron-ore containing 58·8 per cent. of iron, which were sold in 1906 at the rate of £2 a ton, the ferruginous by-product has proved so far useless, since it is a variety too hard to be readily ground to a pigment and not quite suitable for the smelter, even if enough could be obtained.

FIG. 3. Microphotograph of Specular Iron-Tinstone from Birch Tor. *Q*, quartz, all of one generation, in which the other minerals are set; *C*, cassiterite; *S*, specular iron; *T*, tourmaline; *M*, fine mica.

Other occurrences of specular iron in the neighbourhood and elsewhere will now be referred to so as to compare them with that of Birch Tor.

The neighbourhood of Lustleigh, which lies to the east, has long been known as a producer of micaceous or 'shining' ore, and De la Beche states that among its uses this mineral was formerly employed under the name of 'Devonshire Sand', which was sold at the rate of from £3 3*s*. to £8 8*s*. a ton as a writing sand. As it is a soft variety of specular iron it has in recent times been used chiefly as a pigment, but a little has also been smelted.

In a paper read in 1895[1] Mr. Joseph S. Martin described the nature

[1] J. S. Martin, "Micaceous Iron Ore near Bovey Tracey": Trans. Manchester Geol. Soc., 1895, vol. xxiii, p. 162.

of the veins of micaceous iron-ore at the Hawkmoor and Shapter Mines in the parish of Bovey Tracey, near Lustleigh, and mentioned that one of them contained cassiterite. As these lodes have the same general direction as those at Birch Tor, there can be no reasonable doubt that they are of the same age and differ from them only in the larger proportion of iron-ore they contain.

From the Hawkmoor and Shapter lodes, which vary in width from 2 inches to 2 feet, the amount of shining ore obtained between the years 1892 and 1902 was over 1200 tons (including a small quantity from Plumley and Shuttamoor). The ore was a soft variety of specular iron used almost exclusively as a pigment, and according to official returns realized from £4 to £5 a ton.

Although I do not contend that all the ferruginous deposits in this district have a similar mode of origin, it is a suggestive fact that the specular-iron-cassiterite veins should happen to occur in a district already so rich in other ores of iron, such as the magnetite and limonite (brown hæmatite) of Haytor and Ilsington[1] and other localities on the west of Dartmoor.

The nature of the magnetite deposits of Haytor have been studied by (Sir) Clement Le Neve Foster, J. H. Collins, and Dr. Busz, and the results of their work are of interest in this connexion. Dr. Busz examined the ore microscopically, and discovered it to be associated with fibrous hornblende and a little apatite and garnet.[2] Dr. Foster in 1875 stated that the ore contained, in addition to magnetite, actinolite, garnet, axinite, some iron pyrites, chalcedony, chalybite, and fluorspar. He made alternative suggestions regarding its origin, stating that the ore might be either metamorphosed bedded iron-ores, i.e. contact-altered beds of iron-ore once similar to those of Cleveland, or else the result of deposition of iron-ore along beds by means of ferruginous emanations derived from the granite.[3]

After visiting the magnetite mines near Haytor I carefully examined typical specimens of the ore. Although entirely within the metamorphic aureole of the Dartmoor granite, the general structure of the ore and its relation to the country rock left no doubt in my mind of its being an epigenetic deposit and not the result of contact metamorphism acting on a ferruginous bed. Nor are there any greenstones in the mine to account for the presence of the magnetite. The country rock consists of banded Culm sediments, some layers of which show contact alteration phenomena, such as spotting, while others are tough, fine, compact, siliceous bands or coarser micaceous sandy layers, varying from a fraction of an inch in thickness to several inches. Here and there thin veins of granite penetrate the beds. The ore itself consists mainly of hornblende and magnetite, and occurs along certain bands in the sediments. In these orey bands the magnetite occurs as a microscopically fine crystalline layer, ranging up to a foot or so in thickness, which either ends off abruptly against the adjacent siliceous

[1] Over 45,000 tons of iron-ores were raised between 1858 and 1882 from the parish of Ilsington.

[2] Neu. Jahrb. f. Min. u. Geol. (Bauer), 1899–1901, vol. xiii, p. 102.

[3] C. Le Neve Foster, "Notes on Haytor Iron Mine": Quart Journ. Geol. Soc., 1875, vol. xxxi, p. 628.

bands or merges insensibly on both sides into a mass of radiating, curved, green fibres and sheaves of hornblende, which in turn ends abruptly against the adjacent beds of the Culm. Throughout the hornblende small, well-formed, or microscopically fine crystals of magnetite may be seen. The magnetite also occurs as well-formed octahedra encrusting cracks in the hornblende mass and sometimes in association with transparent vein-quartz and a micaceous mineral. As a whole the structures are reminiscent of those seen in some tin veins in killas, in which tin-ore occupies the same relative position with regard to greisen, chlorite, or schorl-rock that the magnetite does to the hornblende (Fig. 4).

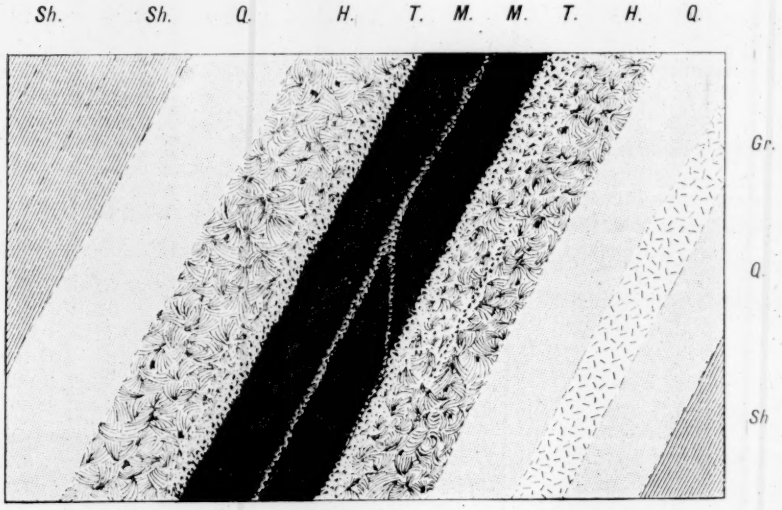

FIG. 4. Diagram illustrating the structure of the magnetic iron-ore deposits at Haytor (reduced to $\frac{3}{4}$ nat. size). *M.*, dense, finely crystalline magnetite with cracks encrusted with well-formed crystals; a little fibrous hornblende is seen in places; *T.*, transition between magnetite and hornblende; *H.*, fibrous hornblende with scattered crystals and specks of magnetite; *Q.*, dense fine siliceous rock resembling a very fine quartzite or chert; *Sh.*, spotted shale; *Gr.*, granite vein.

It appears to me that it is possible to link the ore genetically with the tin-specular-iron veins of Birch Tor, on the assumption that they were impregnations or metasomatic replacements along calcareous beds of the Culm at the time they were undergoing thermal metamorphism. The magnetite deposits may be paralleled with those of Pennsylvania, where calcareous rocks have been replaced by this ore by heated ferruginous solutions.[1] It should be borne in mind, however, that there are many lodes of iron in the west of England, particularly those characterized by the presence of chalybite and small amounts of manganese (e.g. Perran Iron Lode, Newquay, and the lodes of

[1] C. Spencer, Bull. 359, U.S.A., 1908.

Exmoor and Combe Martin), which were undoubtedly formed after the tin-lodes and were in no way connected with pneumatolytic actions. Such lodes are not here being considered.

The geological conditions under which specular iron is found in the tin-lodes of Birch Tor are quite in accord with its usual mode of occurrence, since its common habitat is the crystalline schists and the acid eruptive rocks (both volcanic and plutonic), where it is sometimes accompanied by magnetite. It has been artificially prepared by Messrs. Fouqué and Levy, and has been observed in copper works slag [1] and as a sublimate in alkali works.[2] Its occurrence in the west of England has been frequently recorded, but its connexion with tin-ores has been seen only in small quantities.

Near Hennock a vein of specular iron-ore 2 feet in thickness has been recorded by Lysons.[3] Similar ore has been worked at South Molton, and occurs at Buckfastleigh. During the survey of this district a vein of specular iron-ore in white quartz was found on the north of Water Hill. The specular iron here occurs in unusually large tabular crystals ¼ inch across. In small quantities it is present in the lodes of Wheal Maudlin (St. Austell), Wheal Beauchamp (Gwennap), and Tincroft (Camborne).

To go further afield, it is of interest to know that the mineral occurs plentifully in tin-ore veins of the Mückenberg district at Ober-Graupen, and pseudomorphous after wolfram and fluorspar near the Zinnwald, Bohemia. It occurs in Framont (Vosges) near an intrusion of quartz porphyry, and has recently been noted in tin-ore of the Rooiberg district, Transvaal.

The general conclusions are that the lodes of Birch Tor may be regarded as a special sub-type of tin veins in which the characteristic minerals are quartz, tourmaline, cassiterite, and specular iron free from sulphides, except a little accessory iron pyrites. In the genetic classification based on mineral associations it occupies a transitional position between hæmatite lodes and tin-lodes with sulphidic minerals, as follows:—

1. Hæmatite (including specular iron-ore. Magnetite and ilmenite also come into this group).
2. Specular iron-ore (with magnetite?) and cassiterite.
3. Cassiterite and wolfram.
4. Cassiterite and wolfram with mispickel, chalcopyrite, and other sulphides (and, rarely, argentiferous galena).

The veins of types 2, 3, and 4 are further characterized by the presence of such minerals as tourmaline and fluorspar, and are accompanied by alterations of the country rock to greisen, schorl-rock, and china clay rock.

[1] W. Terrill, "Note on Artificial Crystals of Specular Iron found in a Copper Works Slag": Min. Mag., 1884, vol. v, p. 48.

[2] A. Arzruni, "Comparative Observations on Artificial and Natural Minerals": Zeit. f. Kryst., 1890, vol. xviii, p. 44.

[3] *Magna Britannia* (Devonshire), 1822, p. cclxviii.

VI.—On the Correlation of the English Tertiary Beds with those of the Continent.

By Dr. A. von Koenen, of Göttingen, Germany; For. Corr. Geol. Soc. Lond.

Schimper (*Traité de Paléontologie végétale*, t. iii, p. 680) established in 1874 his Étage paléocène pour les "Sables de Bracheux, Travertins anciens, Lignites et grès du Soissonnais", which are coeval with the Thanet Sands and the Woolwich Series. As there is a natural break between these and the London Clay (= the French Sables de Cuise), and as the Eocene contained more varied faunas than the Oligocene, Miocene, and Pliocene Tertiaries, I accepted that division in my description of the Kopenhague fauna, which formed the Lower Palæocene, together with the Montien of Belgium, older marine beds which are unknown in England.

Quite recently M. Gustave Dollfus kindly sent me his paper "On the Classification of the Beds of the Paris Basin", published in the Proceedings of the Geologists Association in 1909, vol. xxi, pp. 101–18, where (p. 103) he says that I had proposed the term Palæocene for the Montien; "that name is now accepted by many authors and the only objection we have to it is that this name was created by Schimper for the 'Lower Nummulitic'," etc. I wrote about this to M. Dollfus and asked him to correct this statement. Somehow these errors appear singular in an otherwise most able and important paper, but he told me to correct it myself, and it appears that the error has been caused partly by mistake or misprint or by momentary lack of memory. I need not refer to the matter further, but I must notice that all the Lower Tertiaries were named 'Terrain Nummulitique' in older times, and the pre-Nummulitic part of them is exactly the 'Lower Nummulitic', the Palæocene of Schimper including the Montien and the Calcaire pisolithique.

In the same paper (p. 108) M. Dollfus tries to invalidate the evidence adduced by me in my paper in the Quart. Journ. Geol. Soc., May 1864, p. 98, where I showed that out of 56 species of Mollusca from Brockenhurst 6 were peculiar to that locality and the Headon Beds, 46 (not 43) exist in our Lower Oligocene, 21 (not 28) in the Barton Clay, and 23 are characteristic Lower Oligocene species. The Brockenhurst fossils mentioned by me were in the splendid collection of Fred. E. Edwards (now in the British Museum), named and compared by him with his Barton and High Cliff fossils. It is not likely therefore that the number of species common to Brockenhurst and Barton will increase very much. On the other hand, I had a large part of my Lower Oligocene fossils with me, so that they were compared with the English fossils by Mr. Edwards and myself directly. If I really did not mention some of the Brockenhurst species in my monograph of the Lower Oligocene, I may have forgotten it or omitted them, because I had no specimens for a renewed comparison. Out of twelve species of corals from Brockenhurst only two are said now to be identical with species from the Paris Basin and others to be similar; that gives no proof whatever of their relative age. In our Lower Oligocene, which cannot be divided into two different zones, there are other genera of corals besides *Balanophyllia*, so that

there can be no possible comparison with the Brockenhurst Corals. The Molluscan fauna of the Lower Oligocene is exactly identical with the Tongrien inférieur of Belgium, and is very rich (I described 756 species), that of our Rupel Clay being rather poor, so that it is quite impossible that a larger number of fossils could pass from the former to the latter (which contains about 200 species, 70 of which are common to the Lower Oligocene, as I stated in my monograph, p. 1443), and the Upper Oligocene has a well-characterized fauna discovered last year as far west as Boncelles, north of Liége. I must therefore object to separating the Oligocene only into two divisions and to the putting the Brockenhurst Beds in the Upper Eocene.

It is a mistake or misprint that I once cited the Venus Bed from the Lower Headon Series, instead of the Middle; the Lower may belong to the Eocene, which is otherwise represented in the most northern parts of Germany by clay with Crabs and a few Mollusca of the London Clay and basaltic tufa, as in Denmark (Moler). The important beds of brown coal between Halle, Magdeburg, and Brunswick are still doubtful, though I rather believe them to be of Eocene age.

As to the Aquitanien, I am not sure that it is everywhere clearly defined, so that it may belong partly to the Upper Oligocene and partly to the Lower Miocene, containing mostly brackish and fresh-water beds, which so often form "des terrains de passage", or intermediate beds.

VII.—Obsidianites in the Malay Peninsula.

By J. B. Scrivenor, M.A., F.G.S., Geologist to the Federated Malay States Government and formerly of H.M. Geological Survey of the United Kingdom.

THE appearance of Professor E. Weinschenk's paper[1] at the close of last year on two specimens of Moldavite from Kuttenburg, in Bohemia, affords a convenient opportunity of recording occurrences of the related 'obsidianites' (referred to by Professor Weinschenk as Billitonite and Australite) in the Malay Peninsula.

The literature dealing with the occurrences of obsidianites in the Malay Archipelago and Australia is unfortunately scattered. The subject has been fully treated, however, and in view of the origin suggested for Moldavite by Professor Suess and supported by Professor Weinschenk, namely, that these peculiar pieces of glass fell on the earth as meteors, it is interesting to note the lunar-volcanic origin suggested for obsidianites by Dr. Verbeek in 1897,[2] and the admission of the probability of a meteoric origin by Dr. Krause in 1898.[3] On the other hand, Mr. E. S. Simpson,[4] while describing West Australian

[1] "Die kosmische Natur der Moldavite und verwandter Gläser": Centralblatt f. Min. Geol. u. Palaeontologie, December 15, 1908, No. xxiv, pp. 737–42.

[2] R. D. M. Verbeek, "Glaskogels van Billiton-Jaarboek v. h. Mijnwezen in Nederlandsch Oost-Indië": Wetenschappelijk Gedeelte, 1897, pp. 235–72, pl. i.

[3] P. G. Krause, "Obsidianbomben aus Niederländisch Indien-Jaarboek v. h. Mijnwezen in Nederlandsch Oost-Indië": Wetenschappelijk Gedeelte, 1898, pp. 17–31, pl. i.

[4] E. S. Simpson, Geol. Survey of Western Australia, Bull. No. 6, Notes from the Departmental Laboratory, 1902, pp. 79–85, pls. i, vi–viii.

obsidianites in 1902, inclines, apparently, towards the view of their having been derived from terrestrial volcanoes. References to earlier literature will be found in the works of the above-mentioned authors.

A detailed description of the obsidianites in the Malay Peninsula is unnecessary, since they agree with those described and excellently figured by Dr. Verbeek, Dr. Krause, and Mr. Simpson. Dr. Verbeek figures also two specimens of Moldavite (Bouteillesteenen) from Bohemia for comparison with the obsidianites.

With one exception all the specimens that have come under the writer's notice were found in tin-ore bearing alluvium in the Blat and Gambang Valleys in the district of Kuantan, Pahang. The exception is a small obsidianite from the Sudu Seremban Tin-mine, Negri Sembilan, collected by Mr. Leonard Wray in 1904 and now in the Perak Museum, Taiping.

Mr. H. C. Robinson has informed the writer that obsidianites have been found elsewhere in Negri Sembilan, namely, at Gemas and on the Triang River.

Generally the Pahang obsidianites show the "brilliant black lustre, making them appear, as Krause says, as if varnished or lacquered",[1] and they also show the sculpturing that is the chief feature of these remarkable bodies. Sometimes, however, they are distinctly water-worn, which robs them of their lustre and impairs the minute detail of the sculpturing.

A partial analysis of a specimen by Mr. B. J. Eaton, Government Chemist, Kuala Lumpur, shows—

SiO_2	72·60 per cent.
Al_2O_3 and Fe_2O_3 . .	26·00 ,,
CaO	4·00 ,,

The mean specific gravity of three large specimens was found to be 2·46.

The alluvium in which the obsidianites are found is sandy and contains few pebbles. These are mostly quartz, but others of quartz-porphyry and dolerite occur, both rocks being found in situ in the district.

None of the specimens examined by the writer show any trace of the shell of glass which Professor Weinschenk describes[2] as covering about one-third of the surface of the two specimens of Moldavite from Kuttenburg; but seeing how thin and fragile this skin is, its absence in a bed of alluvium containing rolled pebbles is not to be wondered at.

As the writer has no facts to record regarding the Pahang obsidianities helping to terminate the doubt that exists as to their origin, he does not propose to discuss the theories that have been put forward at any length. Professor Weinschenk considers[2] no stronger proof could be given of the cosmic nature of Moldavite than the glass skin, which is interpreted as the result of fusion of the surface of the stones as they fell through the atmosphere, unless they should be observed actually falling. Without assuming the pre-existence of volcanoes now disappeared, the theory of a meteoric origin is the only one that explains the wide distribution of these bodies. The objection that no undoubted meteorites of the same composition are known

[1] Simpson, op. cit., p. 81. [2] Op. cit., p. 739.

is obvious, and if, as the writer understands Mr. Simpson to be inclined to think, obsidianites are bombs hurled enormous distances from terrestrial volcanoes, a thin skin of fused glass might be formed during their descent. To the writer, however, a meteoric origin seems the more probable.

Obsidianites are now known to have been found in the following localities in Malaysia:—Billiton (Verbeek, op. cit.); Mt. Moeriah, Djapara, Java (pp. 245, 246); Pleiari, Tanah Laut, S.E. Borneo (pp. 246, 247); Sungri Riam, Tanah Laut, S.E. Borneo (pp. 246, 247); Bungaran (Natuna Archipelago) (Krause, op. cit.); Blat and Gambang Valleys, Pahang; Gemas and Sungri Triang, Negri Sembilan (H. C. Robinson); Sudu Seremban, Negri Sembilan (L. Wray).[1]

NOTICES OF MEMOIRS.

British Association for the Advancement of Science. Abstract of Address to the Geological Section by Arthur Smith Woodward, LL.D., F.R.S., V.P.Z.S., Sec. G.S., Keeper of Geology in the British Museum, President of the Section. Winnipeg, Canada, August 26, 1909.

THE circumstances of the present meeting very clearly determine the subject of a general address to be expected from a student of extinct animals. The remarkable discoveries of fossil backboned animals made on the North American continent during the last fifty years suggest an estimate of the results achieved by the modern systematic methods of research; while the centenary celebration of the birth of Darwin makes it appropriate to consider the extent to which we may begin deducing the laws of organic evolution from the life of past ages as we now know it.

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There has been an unfortunate tendency during recent years for the majority of geologists to relinquish the study of fossils in absolute despair. More ample material for examination and more exact methods of research have altered many erroneous names which were originally used; while the admission to scientific publications of too many mere literary exercises on the so-called 'law of priority' has now made it necessary to learn, not one, but several names for some of the genera and species which are commonly met with. Even worse, the tentative arrangement of fossils in 'genetic series' has led to the invention of a multitude of terms which often serve to give a semblance of scientific exactitude to the purest guesswork, and

[1] The Pahang obsidianites, like obsidianites elsewhere, have been stated to be pieces of slag resulting from smelting operations. A comparison of the physical and chemical properties of obsidianites and slag from a furnace in operation shows how wide of the mark this view is. A more interesting theory emanated from a Malay Rajah, who told the writer that he had collected a number of these stones and believed each to contain a gem in the centre. A valuation was asked for, and the writer felt sorry that it should fall to his lot to destroy the Rajah's belief by cracking one open for his inspection.

sometimes degenerate into a jargon which is naturally repellent to an educated mind. Nevertheless, I still hope to show that, with all these difficulties, there is so much of fundamental interest in the new work that it is worth while to make an effort to appreciate it.

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In this connexion it is necessary to combat the mistaken popular belief that the main object of studying fossils is to discover the 'missing links' in the chain of life. We are told that the idea of organic evolution is not worthy of serious consideration until these links, precise in character, are forthcoming in all directions. Moreover, the critics who express this opinion are not satisfied to consider the simplest cases, such as are afforded by some of the lower grades of 'shell-fish' which live together in immense numbers and have limited powers of locomotion.

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They even expect continual discoveries of links among the rarest of all fossils, those of the higher apes and man. The geologist, on the other hand, knowing well that he must remain satisfied with a knowledge of a few scattered episodes in the history of life which are always revealed by the merest accident, marvels that the discovery of 'missing links' is so constant a feature of his work. He is convinced that, if circumstances were more favourable, he would be able to satisfy the demand of the most exacting critic. He has found enough continuous series among the mollusca, for example, and so many suggestions of equally gradual series among the higher animals, that he does not hesitate to believe without further evidence in a process of descent with modification.

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Among these general features which have been made clear by the latest systematic researches, I wish especially to emphasize the interest and significance of the persistent progress of life to a higher plane, which we observe during the successive geological periods. For I think palæontologists are now generally agreed that there is some principle underlying this progress much more fundamental than chance-variation or response to environment, however much these phenomena may have contributed to certain minor adaptations. Consider the case of the backboned animals, for instance, which I happen to have had special opportunities of studying.

We are not likely ever to discover the actual ancestors of animals on the backboned plan, because they do not seem to have acquired any hard skeleton until the latter part of the Silurian period, when fossils prove them to have been typical and fully developed, though low in the backboned scale. The ingenious researches and reasoning of Dr. W. H. Gaskell, however, have suggested the possibility that these animals originated from some early relatives of the scorpions and crustaceans. It is therefore of great interest to observe that the Eurypterids and their allies, which occupy this zoological position, were most abundant during the Silurian period, were represented by species of the largest size immediately afterwards at the beginning of the Devonian, and then gradually dwindled into insignificance. In

other words, there was a great outburst of Eurypterid life just at the time when backboned animals arose; and if some of the former were actually transformed into the latter, the phenomenon took place when their powers both of variation and of multiplication were at their maximum.

Fishes were already well established and distributed over perhaps the greater part of the Northern Hemisphere at the beginning of Devonian times; and then there began suddenly a remarkable impulse towards the production of lung-breathers, which is noticeable not only in Europe and North America but also probably so far away as Australia. In the middle and latter part of the Devonian period most of the true fishes had paddles, making them crawlers as much as swimmers; many of them differed from typical fishes, while agreeing with lung-breathers, in having the basis of the upper jaw fused with the skull, not suspended; and some of them exhibited both these features. Their few survivors at the present day (the Crossopterygians and Dipnoans) have also an air-bladder, which might readily become a lung. The characteristic fish-fauna of the Devonian period therefore made a nearer approach to the land animals than any group of fishes of later date; and it is noteworthy that in the Lower Carboniferous of Scotland—perhaps even in the Upper Devonian of North America, if footprints can be trusted—amphibians first appeared. In Upper Carboniferous times they became firmly established, and between that period and the Trias they seem to have spread all over the world; their remains having been found, indeed, in Europe, Spitzbergen, India, South Africa, North and South America, and Australia.

The Stegocephala or Labyrinthodonts, as these primitive amphibians are termed, were therefore a vigorous race; but the marsh-dwelling habits of the majority did not allow of much variation from the salamander pattern. Only in Upper Carboniferous and Lower Permian times did some of their smaller representatives (the Microsauria) become lizard-like, or even snake-like in form and habit; and then there suddenly arose the true reptiles. Still, these reptiles did not immediately replace the Stegocephala in the economy of nature; they remained quite secondary in importance at least until the Upper Permian, in most parts even until the dawn of the Triassic period. Then they began their flourishing career.

At this time the reptiles rapidly diverged in two directions. Some of them were almost exactly like the little *Sphenodon*, which still survives in some islands off New Zealand, only retaining more traces of their marsh-dwelling ancestors. The majority (the Anomodonts or Theromorphs) very quickly became so closely similar to the mammals that they can only be interpreted as indicating an intense struggle towards the attainment of the higher warm-blooded grade; and there is not much doubt that true mammals actually arose about the end of the Triassic period. Here again, however, the new race did not immediately replace the old, or exterminate it by unequal competition. Reptiles held their own on all lands throughout the Jurassic and Cretaceous periods, and it was not until the Tertiary that mammals began to predominate.

As to the beginning of the birds, it can only be said that towards the end of the Triassic period there arose a race of small Dinosaurs of the lightest possible build, exhibiting many features suggestive of the avian skeleton; so it is probable that this higher group also originated from an intensely restless early community of reptiles, in which all the variations were more or less in the right direction for advancement.

In short, it is evident that the progress of the backboned land animals during the successive periods of geological time has not been uniform and gradual, but has proceeded in a rhythmic manner. There have been alternations of restless episodes which meant real advance, with periods of comparative stability, during which the predominant animals merely varied in response to their surroundings, or degenerated, or gradually grew to a large size. There was no transition, for instance, between the reptiles of the Cretaceous period and the mammals which immediately took their place in the succeeding Eocene period: those mammals, as we have seen, had actually originated long ages before, and had remained practically dormant in some region which we have not yet discovered, waiting to burst forth in due time. During this retirement of the higher race the reptiles themselves had enjoyed an extraordinary development and adaptation to every possible mode of life in nearly all parts of the globe. We do not understand the phenomenon—we cannot explain it; but it is as noticeable in the geological history of fishes as in that of the land animals just considered. It seems to have been first clearly observed by the distinguished American naturalist, the late Professor Edward D. Cope, who termed the sudden fundamental advances 'expression points', and saw in them a manifestation of some inscrutable inherent 'bathmic force'.

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The demonstration by fossils that many animals of the same general shape and habit have originated two or three times, at two or three successive periods, from two or three continually higher grades of life, is very interesting. To have proved, for example, that flying reptiles did not pass into birds or bats, that hoofed Dinosaurs did not change into hoofed mammals, and that Ichthyosaurs did not become porpoises, and to have shown that all these later animals were mere mimics of their predecessors, originating independently from a higher yet generalized stock, is a remarkable achievement. Still more significant, however, is the discovery that towards the end of their career through geological time totally different races of animals repeatedly exhibit certain peculiar features, which can only be described as infallible marks of old age.

The growth to a relatively large size is one of these marks, as we observe in the giant Pterodactyls of the Cretaceous period, the colossal Dinosaurs of the Upper Jurassic and Cretaceous, and the larger mammals of the Pleistocene and the present day. It is not, of course, all the members of a race that increase in size; some remain small until the end, and they generally survive long after the others are extinct; but it is nevertheless a common rule that the prosperous and typical representatives are successively larger

and larger, as we see them in the familiar cases of the horses and elephants of the Northern Hemisphere and the hoofed animals and armadillos of South America.

Another frequent mark of old age in races was first discussed and clearly pointed out by the late Professor C. E. Beecher, of Yale. It is the tendency in all animals with skeletons to produce a superfluity of dead matter, which accumulates in the form of spines or bosses as soon as the race they represent has reached its prime and begins to be on the down grade. Among familiar instances may be mentioned the curiously spiny Graptolites at the end of the Silurian period, the horned Pariasaurians at the beginning of the Trias, the armour-plated and horned Dinosaurs at the end of the Cretaceous, and the cattle or deer of modern Tertiary times. The last case—that of the deer—is specially interesting, because fossils reveal practically all the stages in the gradual development of the horns or antlers, from the hornless condition of the Oligocene species, through the simply forked small antlers of the Miocene species, to the largest and most complex of all antlers seen in *Cervus sedgwicki* from the Upper Pliocene and the Irish deer (*C. giganteus*) of still later times.

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Finally, in connexion with these obvious symptoms of old age in races, it is interesting to refer to a few strange cases of the rapid disappearance of whole orders of animals, which had a practically worldwide distribution at the time when the end came. Local extinction, or the disappearance of a group of restricted geographical range, may be explained by accidents of many kinds; but contemporaneous universal extinction of widely spread groups, which are apparently not affected by any new competitors, is not so easily understood. The Dinosaurs, for instance, are known to have lived in nearly all lands until the close of the Cretaceous period; and, except perhaps in Patagonia, they were always accompanied until the end by a typically Mesozoic fauna. Their remains are abundant in the Wealden formation of Western Europe, in the deposits of a river which must have drained a great continent at the beginning of the Cretaceous period; they have also been found in a corresponding formation which covers a large area in the State of Bahia, in Brazil. They occur in great numbers in the freshwater Upper Cretaceous Laramie deposits of Western North America, and also in a similar formation of equally late date in Transylvania, South-East Europe. In only two of these regions (South-East Europe and Western North America) have any traces of mammals been found, and they are extremely rare fragments of animals as small as rats; so there is no reason to suppose that the Dinosaurs suffered in the least from any struggle with warm-blooded competitors. Even in Patagonia, where the associated mammal-remains belong to slightly larger and more modern animals, these fossils are also rare, and there is nothing to suggest competition. The race of Dinosaurs seems, therefore, to have died a natural death. The same may be said of the marine reptiles of the orders Ichthyosauria, Plesiosauria, and Mosasauria. They had a practically worldwide distribution in the seas of the

Cretaceous period, and the Mosasauria especially must have been extremely abundant and flourishing. Nevertheless, at the end of Cretaceous times they disappeared everywhere, and there was absolutely nothing to take their place until the latter part of the Eocene period, when whales and porpoises began to play exactly the same part. So far as we know, the higher race never even came in contact with the lower race; the marine mammals found the seas vacant, except for a few turtles and for one curious Rhynchocephalian reptile (*Champsosaurus*), which did not long survive. Another illustration of the same phenomenon is probably afforded by the primitive Carnivora (the so-called Sparassodonta), which were numerous in South America in the Lower Tertiary periods. They were animals with a brain as small as that of the thylacines and dasyures which now live in Tasmania. They appear to have died out completely before they were replaced by the cats, sabre-toothed tigers, and dogs, which came down south from North America over the newly emerged Isthmus of Panama at the close of the Pliocene period. At least, the remains of these old carnivores and their immigrant successors have never yet been found associated in any geological formation.

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I am therefore still inclined to believe that the comparison of vital processes with certain purely physical phenomena is not altogether fanciful. Changes towards advancement and fixity which are so determinate in direction, and changes towards extinction which are so continually repeated, seem to denote some inherent property in living things, which is as definite as that of crystallization in inorganic substances. The regular course of these changes is merely hindered and modified by a succession of checks from their environment and by Natural Selection. Each separate chain of life, indeed, bears a striking resemblance to a crystal of some inorganic substance which has been disturbed by impurities during its growth, and has thus been fashioned with unequal faces, or even turned partly into a mere concretion. In the case of a crystal the inherent forces act solely on molecules of the crystalline subject itself, collecting them and striving, even in a disturbing environment, to arrange them in a fixed geometrical shape. In the case of a chain of life (or organic phylum) we may regard each successive animal as a temporary excrescence of colloid substance round the equally colloid germ-plasm which persists continuously from generation to generation. The inherent forces of this germ-plasm, therefore, act upon a consecutive series of excrescences (or animal bodies), struggling, not for geometrically arranged boundaries, but towards various other symmetries, and a fixity in number of multiple parts. When the extreme has been reached, activities cease, and sooner or later the race is dead.

Such are some of the most important general results to which the study of fossils has led during recent years; and they are conclusions which every new discovery appears to make more certain.

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Serious difficulties have also become apparent during recent years in

determining exactly the origin of the mammals. For a long time after the discovery of the Anomodont or Theromorph reptiles in the Permian-Trias of South Africa, it seemed more and more probable that the mammals arose in that region. Even yet new reptiles from the Karroo formation are continually being described as making an astonishingly near approach to mammals; and, so far as the skeleton is concerned, the links between the two grades are now very numerous among South African fossils. Since these reptiles first attracted attention, however, they have gradually been found in the Permian and Trias of a large part of the world. Remains of them were first met with in India, then in North America, and next in Scotland, while during the last few years Professor W. Amalitzky has disinterred so many nearly complete skeletons in the north of Russia that we are likely soon to learn more about them from this European country than from the South African area itself. Quite lately I have received numerous bones from a red marl in Rio Grande do Sul, Southern Brazil, which show that not merely Anomodonts but also other characteristic Triassic land reptiles were likewise abundant in that region. We are therefore now embarrassed by the richness of the sources whence we may obtain the ancestors of mammals.

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The mystery of the origin of the marine mammals of the order Sirenia and Cetacea appears to have been diminished by the discoveries of the Geological Survey of Egypt, and by those of Dr. Andrews and Dr. Fraas in the Eocene and Oligocene deposits of the Mokattam Hills and in the Fayûm. It is now clear that the Sirenians are closely related to the small primitive ancestors of the elephants; while, so far as the skull and dentition are concerned, we know nearly all the links between the early toothed whales (or Zeuglodonts) and the primitive ancestors of the Carnivora (or Creodonts). The most primitive form of Sirenian skull hitherto discovered, however, is not from Egypt, but from the other side of the world, Jamaica; and exactly the same Zeuglodonts, even with an associated sea-snake, occur so far away from Egypt as Alabama, U.S.A. The problem of the precise origin of these marine mammals is therefore not so simple as it would have appeared to be had we known only the Egyptian fossils. The progress of discovery, while revealing many most important generalities, has made it impossible to vouch for the accuracy of the details in any 'genealogical tree'.

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It would be easy to multiply instances, but I think I have now said enough to show that every advance in the study of fossils reveals more problems than it solves. During the last two decades the progress in our knowledge of the extinct backboned animals has been truly astonishing, thanks especially to the great explorations in North America, Patagonia, Egypt, Madagascar, and South Africa. Whole groups have been traced a long way towards their origin; but with them have been found a number of previously unknown groups which complicate all questions of evolution to an almost bewildering extent. Animals formerly known only by fragments are now represented

by nearly complete skeletons, and several which appeared to have a restricted geographical range have now been found over a much wider area; but while this progress has been made, numerous questions have arisen as to the changing connexions of certain lands and seas which previously seemed to have been almost settled. The outlook both of zoology and geology has, therefore, been immensely widened, but the only real contribution to philosophy has been one of generalities. Some of the broad principles to which I have referred are now so clearly established that we can often predict what will be the main result of any given exploration, should it be successful in recovering skeletons. We are no longer bold enough to restore an entirely unknown extinct animal from a single bone or tooth, like the trustful Cuvierian school; but there are many kinds of bones and teeth of which we can determine the approximate geological age and probable associates, even if we have no exact knowledge of the animals to which they belong. A subject which began by providing material for wonder-books has thus been reduced to a science sufficiently precise to be of fundamental importance both to zoology and to geology; and its exactitude must necessarily increase with greater and greater rapidity as our systematic researches are more clearly guided by the experience we have already gained.

REVIEWS.

I.—The Natural History of Igneous Rocks. By Alfred Harker, M.A., F.R.S. 8vo; pp. xvi, 384, with 112 diagrams and 2 plates. Methuen & Co., London. Price 12*s*. 6*d*. net.

FOR more than twenty years Dr. Harker has advocated that the igneous rocks should generally be treated in reference to geological age and to the part which they have played in the tectonics of the earth's crust. Many papers have been published that consist of descriptions of the microscopic structure and mineral constituents of rocks, with little or no reference to the geological history of the region from which they have been collected. This descriptive side of petrology, or petrography, is but a part of the 'rational petrology' that should be dealt with in relation to historical geology.

It must be remembered, however, that in many cases it has not been possible to determine the particular age of intrusive rocks, and it is therefore not surprising that petrographical details have often been "relegated to a more or less perfunctory appendix" in various publications. Our knowledge, however, has vastly increased during the past quarter of a century, a fact very clearly shown in the volume before us.

While recognizing that "cosmogony is at least as much in the province of the geologist as in that of the astronomer", the author is content to refer very briefly to hypotheses relating to the genesis of our planet, and to the possible influence of radium on the temperature gradient, as "the present situation is so unsettled that one who is not directly led to discuss these large questions may legitimately adopt towards them an attitude frankly agnostic". Moreover, "the

problems of petrology are in great measure independent of the speculations of cosmogony."

We have, therefore, a suitable starting-point in the data furnished by geological observation, data which from an historical point of view are supplied more fully in the British Isles than elsewhere. The geological record indicates that there were great periods of igneous activity, separated by intervals of quiescence; but that there is no evidence of a decline of igneous energy, nor of any differences in the types of intrusive or extrusive rocks in different ages. In most cases, where clear evidence has been obtained, the sequence of events has been (1) volcanic or extrusive, (2) large plutonic intrusions, (3) minor intrusions.

The indiscriminate use by some writers of the terms 'vulcanicity' and 'volcanic rocks' for igneous phenomena in general, is deprecated by the author. The superficial outbursts cannot be regarded as the most important results of igneous action unless from a present-day and personal point of view. Despite the enormous outpourings of lava that have taken place in some regions, it is pointed out that intruded rock-masses enter much more largely into the outer crust of the earth, and there is more to be learnt from the records displayed in eroded regions of former igneous activity than from a contemplation of active volcanoes. An analogous process is in many respects applicable to the study of glacial phenomena. In the case of igneous rocks, however, "Instead of applying a knowledge of processes now going on around us to elucidate the record of past ages, we must seek rather to use the history of the past to explain the phenomena of the present."

As the author remarks, "Igneous action, in its dynamic aspect, consists in the moving of a body of magma from one situation to another, in response to differences of fluid pressure; but whether or not some part of the magma is forced out at the surface depends upon conditions of the second order of importance."

Without discussing at any length the origin of igneous magmas, the author points out that modern volcanoes negative the idea that they draw *directly* upon a common source or 'stock-reservoir', as evidenced by differences in the levels of lava columns in adjacent areas and in the composition of ejected materials. Nevertheless, community of relationship and of origin is met with in some cases, indicating an extensive magma-basin or series of basins. The ascertained facts lead to the conclusion that there are reservoirs of molten magma of different magnitudes and permanence, and that when exhausted by eruption or solidified, subsequent outbursts may be caused by re-melting or by fresh accessions of molten material from deeper sources. Indeed, "the largest igneous rock-masses known to geologists may represent subsidiary reservoirs, which were only off-shoots from the main basin and at a higher level. In confirmation of this, it is found that such masses very generally give evidence of distinctly intrusive relations, and are sharply separable from the contiguous rocks, which, though highly metamorphosed, show no sign of fusion."

Geological evidence proves that there has been a general, but not invariable, correspondence between igneous action and important movements in the earth's crust, such as those of elevation and depression,

folding, faulting, and overthrust; and "the cause of the displacement of bodies of rock-magma is to be sought in readjustment of the Earth's crust, which has become subjected to powerful stresses as a consequence of deformation".

These crust-movements are termed respectively the movements of plateau-building and of mountain-building. In plateau-building there may have been upheaval or depression of great blocks, and the volcanic action manifested in connexion with them takes the form of fissure eruptions. In mountain-building the main movements were due to lateral thrust, accompanied by much folding and overthrusting, and by what the author terms central eruptions. These eruptions are regarded as due chiefly to relief of pressure in certain deep-seated parts of the crust, where "such conditions of temperature and pressure prevail that solid and liquid rock are in approximate thermal equilibrium".

In the case of fissure eruptions the outpouring may be due to "the mere pressing outward of the fluid magma through fissures concurrently opened, with a corresponding settling down of the heavier solid crust which overlay the magma". Thus the Inner Hebrides form parts of a sunken faulted area, on the margin of which igneous outpourings took place.

The old idea that eruptions may be caused by the penetration of oceanic water to the region of the molten magmas is shown to be untenable, the theory requiring us "to believe that steam can force its way, against enormous pressure, through capillary channels in the deeper parts of the Earth's crust". On the other hand, water is present in all igneous rocks, amounting "on the average to about 1½ per cent., a proportion quite sufficient to endow the molten rock with the properties displayed in volcanic eruptions". The author is rather disposed to consider, not that the sea is the source of volcanic water, but that vulcanicity "is the original source of the oceanic waters, and is slowly adding to them".

In giving, largely in his own words, a summary of his views on the more generally interesting phenomena of igneous action, we have left little space for any account of the author's more detailed descriptions of fissure and central eruptions, and of the types of rock met with in plateau-building and mountain-building—of sills and laccolites, of phacolites, dykes, and batholites. In some cases, as pointed out, laccolites may be the immediate cause of folding and faulting, in others they appear as a consequence of displacements.

The idea of certain large magma basins is supported by a study of petrographical provinces, but the magma itself may undergo such differentiation that drafts from it differ widely in composition. The mutual relations of associated igneous rocks, the order of intrusion, and the order of crystallization are all dealt with, as well as various rock-structures and the effects of pneumatolytic action. The author is opposed to the view that there is any great amount of assimilation of bordering rocks by intrusive masses.

The final chapter deals with the classification of igneous rocks, and the author leaves to the future the establishment of a satisfactory genetic classification.

In conclusion, we may commend the work, not only as a record of knowledge based on extensive personal research, but as one exhibiting great thought and care in the systematic presentation of facts and of philosophic judgment in dealing with the explanation of them.

II.—Geological Survey Memoirs.

1. The Geology of the Small Isles of Inverness-shire. By Alfred Harker, F.R.S., with contributions by G. Barrow, F.G.S. pp. ix, 210, with 10 plates and 50 text-illustrations. Price 4*s.* 6*d.* Hand-coloured geological map, Sheet 60 (Scotland); price 10*s.* 3*d.*

THE Small Isles include Rum, Eigg, Canna, Sanday, Muck, and Oigh-sgeir, with some smaller islets. The rocks described include the Torridonian of Rum, the Jurassic (Great Oolite Series and Oxfordian) of Eigg and Muck, the newly discovered Upper Cretaceous rocks of Eigg, and the Tertiary igneous rocks, representatives of which, together with glacial and later superficial deposits, are met with in all the islands. Of special interest are the researches on the Tertiary gneisses of Rum, which closely resemble those of the Lewisian formation, and the further observations on the intrusive character of the pitchstone of the Sgùrr of Eigg. Considerable additions are made to our knowledge of the Secondary rocks and fossils, notably in the discovery of chalky sandstone with flints, Foraminifera, and fragments of *Inoceramus*, probably representing a part of the Chalk formation.

2. The Geology of the Country North and East of Harrogate. Second edition. By C. Fox-Strangways, F.G.S. pp. v, 100, with 8 plates and 6 text-illustrations. Price 2*s.* 6*d.* Hand-coloured geological map, Sheet 62 (old series 93 N.W.), England; price 8*s.* 3*d.*

IT is satisfactory to find that a new edition of the memoir on the popular inland watering-place of Harrogate has been required, and that the author of the original edition (dated 1873, but not issued until 1874) has been able to prepare it. The work is illustrated by a useful colour-printed map of the immediate neighbourhood of Harrogate, and by interesting pictorial illustrations, from photographs by Mr. Godfrey Bingley, of the Plumpton Rocks, the Knaresborough Dropping Well, etc., and by new sections showing the general structure of the district. The physiography receives more attention. There is a full account of the Harrogate waters, and a practically complete bibliography relating to the geology and mineral waters of the district.

We note that the price of the hand-coloured map, which has not undergone revision, has been raised from 3*s.* to 8*s.* 3*d.* In fact, an examination of the Geological Survey List of Memoirs, Maps, etc., for 1909 shows that the prices of a large number of maps have been raised so as in many cases to be prohibitive. Thus the geologist who could purchase the Drift edition of Sheet 6 (Bromley, Maidstone, Tunbridge Wells, etc.) for 8*s.* 6*d.* is now expected to pay 26*s.*! The same change

in price has been made in the Drift map of Lincoln, Sheet 83. The map of Norwich, 66 N.E., formerly priced at 3*s.*, is now 9*s.* 9*d.*, and the Scottish map 37 (Inverary, etc.) has been raised from 6*s.* to 25*s.* 3*d.* This is surely a retrograde movement on the part of H.M. Treasury.

III.—Handbook for Field Geologists. By C. W. Hayes, Ph.D., Chief Geologist, United States Geological Survey. Second edition. Small 8vo; pp. ix, 159, with 18 figures. New York and London: Chapman & Hall, 1909. Price 6*s.* 6*d.* net.

THIS little handbook is one that may be consulted advantageously by all field geologists, by teachers, and by students who are desirous of joining the staff of a Geological Survey.

After referring briefly to the physical and mental qualities and adaptability to conditions requisite in a field geologist, the author rightly urges that a thorough grounding in chemistry, physics, zoology, and botany is the best preparation for geologic work, and that this should be secured even at the expense of certain geologic information that can be better learnt during the progress of field-work. Some knowledge also of mathematics and of modern languages is regarded as essential.

The requirements of the geological surveyor vary naturally in different regions, his work being much more arduous and diversified not only in complex mountain regions, but in countries where the climate is extreme and where topographic maps have to be constructed.

In the United States Geological Survey, under the Director, there are four branches: the Geologic Branch under the Chief Geologist, the Topographic Branch under the Chief Geographer, the Water Resources Branch under the Chief Hydrographer, and the Technologic Branch under an Expert in Charge.

The present handbook contains instructions relating almost exclusively to the geologic branch, and we miss therefore any special advice with regard to water supply; the investigation of oil and gas fields, however, is included.

Among other qualifications necessary in the United States it is held that "A geologist must possess a practical knowledge of horsemanship, of boating, and of general woodcraft, so that he will be equally at home in the saddle, in the canoe, or on foot in a trackless forest". Useful instructions are given in the matter of outfit, and neatness in dress is strongly urged.

As the author observes, "Directions for making and recording observations and for the use of the schedules are intended to insure thoroughness and system, not to relieve the observer of the necessity for thought." Ability to write clear and concise English is regarded as second in importance only to scientific knowledge.

The study of previous geologic work is recommended prior to a field survey; thus, "Such previous work should be utilized to the utmost, but the geologist should guard, on the one hand, against following former conclusions slavishly and, on the other, against going out of his way to prove his predecessor in the wrong."

While urging the necessity of accurate, systematic work, "the field geologist must avoid the opposite extremes of becoming lost in a mass of detail which cannot be represented" on the map. When, however, the author remarks "It requires the same alertness at the end of a long day as at its beginning", we should be inclined to recommend that if alertness begin to fail the geologist should leave intricate ground to make necessary traverses or devote himself to collecting rock-specimens or fossils, or return forthwith to camp.

There are helpful notes on the uses of various instruments, with mathematical calculations and data for determining thicknesses, depth, and faults; advice is also given on mine surveys and on the collection of rock-specimens, minerals, and fossils. Concerning fossils it is recommended that "All specimens taken from one bed in one locality, though representing many species, should be given the same number and label".

A committee is appointed on the United States Geological Survey to deal with geologic names, advising in reference to new terms suggested for stratigraphic divisions, etc.

In the second portion of this book there are detailed instructions for special investigations on petrologic and chemical subjects, structural geology, glaciers and glacial deposits, and metalliferous deposits, with due regard to both scientific and practical applications.

We may cordially commend the book to all Government geologists and to those engaged in private economic and other geological field-work.

IV.—On the Anaspidacea, living and fossil. By Geoffrey Smith. Quarterly Journal of Microscopical Science, vol. liii, pt. iii, May, 1909.

IN 1907 Mr. Geoffrey Smith, of New College, Oxford, undertook a journey to Tasmania, chiefly for the purpose of investigating the structure and development of the 'Mountain Shrimp', *Anaspides tasmaniæ*, which is of special interest on account of its relationship to the fossil Syncarida of Palæozoic rocks. In the present memoir he sets forth the results of his researches and also attempts a review of all that is known regarding the living and fossil Syncarida. Besides adding largely to our knowledge of the internal structure of *Anaspides*, Mr. Smith discovered, in the 'Great Lake' of Tasmania, a very interesting new member of the same group, which he names *Paranaspides lacustris*, so that, with *Koonunga cursor*, described in 1907 by Mr. O. A. Sayce, we now know three living species of Syncarida. This is not the place to discuss the account given of the living forms, but it may be mentioned in passing that the figures of the limbs and mouth-parts are extremely sketchy and that the discussion of their morphology is in many respects inadequate; throughout the descriptions of the thoracic limbs the ischiopodite is termed the propodite, and the statement on p. 502 that an extra thoracic somite "has been supposed to be present in the Euphausiidæ" appears to be entirely imaginary.

Of the fossil forms, the author, we gather, does not profess to have any first-hand knowledge. This is the more to be regretted since

a re-examination of the fossils in the light of our knowledge of the living forms could hardly fail to yield results of much interest. As it is, the only fossil yet examined in this light is *Præanaspides*, recently described in the pages of this Magazine by Dr. Henry Woodward.[1] For the others Mr. Smith reproduces, in diagrammatic fashion, the restorations given by the older writers, and attempts to extract from these restorations material for a more detailed comparison with the living forms than has hitherto been given. The results of this comparison are expressed in a new classification of the group, in which *Præanaspides* is included in the Anaspididæ and the other fossil genera (except *Acanthotelson*) in a distinct family, Gampsonychidæ. The reasons for taking this step are not apparent from the definitions which Mr. Smith gives for these families; and, in any case, it is decidedly premature in view of the manifest imperfections in our knowledge of the fossils. The suggestion that *Acanthotelson* may be a primitive Amphipod seems singularly inappropriate.

In discussing the relationships of the Syncarida to the other Malacostraca, Mr. Smith emphasizes, with justice, the many primitive characters of this ancient group: but the place which he assigns to them in the phylogeny of the Malacostraca leads to some strange conclusions. For example, the carapace, which is well developed in the Phyllocarida, the most primitive of the Malacostraca, is supposed to have been lost in some Syncarid-like ancestor of the Peracarida and Eucarida, and to have been re-developed independently in each of these groups. Only the strongest evidence would justify the assumption of so remarkable a course of evolution, but, as a matter of fact, there is no evidence at all. We know from the researches of Peach (recently reviewed in these pages) and others that coeval with the fossil Syncarida were a variety of Crustacea presenting the 'caridoid facies'. These Crustacea possessed a well-developed carapace, and may, for all we know, have presented all the characters which we regard as primitive in the recent Syncarida. Some of them had already developed, as Dr. Henry Woodward has shown in *Pygocephalus*, the brood-pouch of the Peracarida, which Mr. Smith derives from an entirely mythical brood-pouch of the Phyllocarida. It is quite possible that among these caridoid Carboniferous forms may have been the common ancestor of the Eucarida and Peracarida, if that ancestor is not to be sought for in a yet earlier period, as is suggested by the Devonian 'Isopod' *Oxyuropoda*; and it is a reasonable assumption that the Carboniferous Syncarida also arose from one of these caridoid forms by suppression of the carapace while retaining other primitive and generalized characters. W. T. Calman.

V.—Die Anheftung der Brachiopoden als Grundlage der Gattungen und Arten. [The Attachment of Brachiopods as Basis of Genera and Species.] By N. Yakowlew. Mém. du Com. géol. St. Petersbourg, nouv. sér., 1908, livr. xlviii, pp. 1–32.

In this contribution the author demonstrates that the views expressed by him in a previous article entitled "Sur la fixation des

[1] Geol. Mag., 1908, Dec. V, Vol. V, pp. 385–96.

coquilles de quelques *Strophomenacea*" (Bull. Com. géol., 1907, vol. xxvi, pp. 181–201) are also applicable to the *Spiriferacea* and *Terebratulacea*. Some of the conclusions arrived at are given herewith.

The attachment of Brachiopods gives rise to alteration in the shape of the shell. Considerable difference may occur in this respect between neighbouring individuals dependent upon the relative conditions of attachment of each individual. Distinctions of shape in the shell arising from such a cause cannot, however, be considered as even of varietal value. The Devonian *Spirifer verneuili*, Murch., and *Sp. rugulatus*, Kutorg., each affords instances of great variability within the limits of the species, and many of these variations have given rise to new specific designations. The development of the ear-like extensions is affected by the nature of the attachment, but the usually curved condition of the areal surface depends upon the straightness of the hinge-margin, and not upon the attachment of the areal portion to an underlying body. In certain cases the change undergone by the members of the *Spiriferacea* consequent upon the attachment has given rise to so-called generic differences as in the case of *Cyrtia* and *Cyrtina*.

The type of the genus *Cyrtia* (*Cyrtia exporrecta*, Dalm.) is synonymous with *Spirifer plicatellus*, an examination of the Stockholm Museum collection of Silurian fossils from Gottland having shown that the distinguishing feature (the presence in *Cyrtia* of a pedicle opening in the pseudodeltidium) is inconstant. In fact, *Cyrtia exporrecta* represents individuals of *Spirifer plicatellus* differing primarily in the growth of an elevated area, and the correlative appearance of a circular opening in the pseudodeltidium. The Devonian *Cyrtia murchisoniana* represents a group which undoubtedly belongs to one species, while the relationship of *Cyrtina heteroclyta* and *Spirifer elegans* is considered to be analogous to that between *Cyrtia exporrecta* and *Spirifer plicatellus*. The *Spiriferacea* of the Alpine Trias present peculiar difficulties, and it is doubtful in many cases whether we have to do with *Spiriferinæ* or *Cyrtinæ*. The author differs from Bittner and Zugmayer in the latitude allowed in the interpretation of several species. The Upper Palæozoic *Cyrtinæ*, like the Triassic, are held to be traceable from *Spiriferina*. *Cyrtina carbonaria*, McCoy, is shown to possess a plate adjacent to the spondylium, which plate is considered by the author to correspond to a pseudodeltidium. A similar feature is proved to exist in *Spiriferina suessi*. Attachment is also considered in its bearing upon the convergence characters of Brachiopod development. The fixation is found to have a relationship not only to the development of a high area and a pseudodeltidium but also to that of a spondylium. *Terebratula*, *Trigonosemus*, and *Terebrirostra* are treated from the same standpoint. In agreement with Davidson *Cistella neapolitana* and *C. biplicata* are considered synonymous, the differences between the two being occasioned by the nature of attachment. In the latter part of the article attention is drawn to the occurrence in certain districts of several Brachiopod types characterized by elongation of the ventral valves. Thus there occur in the Permo-Carboniferous of the Donjetz Basin elongated *Spiriferina* and *Meekella*, and *Spirifer*

curvirostris and *Strophalosia* in the Permian of Kirilov; in the Polish Devonian fauna *Reticularia* and *Spirifer* become drawn out, while *Retzia* and *Spiriferina* occur in the Alpine Triassic fauna, and *Scacchinella*, *Tegulifera*, elongated *Meekella*, and *Spiriferina* in the Permo-Carboniferous of the Carinthian Alps. The contemporaneous occurrence of such forms is due to external conditions, probably as a result of the rapid accumulation of large masses of sediment.

The paper is accompanied by two plates of fossil illustrations.

I. T.

VI.—Brief Notices.

1. Rhodesia Museum.—From the Seventh Annual Report, 1908, just to hand we learn that the Directors of the British South Africa Company have presented a piece of ground 140 by 150 feet in Bulawayo for the purpose of extension of the premises. The Trustees of the Beit Bequest have granted £2500 towards the cost of the new buildings, and a start will be made during the present year in the building of new quarters on this permanent site, allowing for future extensions. The geological accessions are mainly confined to minerals, of which the curator, Mr. F. P. Mennell, reports a fine series. Mr. E. C. Chubb, the curator of Zoology, has paid especial attention to the exhibition of local birds, of which the Museum now possesses a good collection.

2. New Ideas on the Formation of Coral Reefs.—Dr. F. Wood Jones gave a demonstration at the Zoological Society's meeting on June 15 of the method of formation of coral reefs. The purpose of the demonstration was to show that the theories of subsidence put forward by Darwin and of solution put forward by Murray were both untenable in the light of actual facts. A fresh hypothesis—that sedimentation is the most important factor—was substituted for these theories: and it was pointed out that the atoll was in reality a structure analogous to the *Porites* colonies, the upper surfaces of which were made basin-shaped by sediment obliterating the zooids of the central area; that the deposition of sediment below the "limiting line of sedimentation" probably accounted for the bathymetrical limit of the reef-building corals, and for the formation of sedimentation banks up to that line; that in the making of an atoll from the basin-shaped reef the winds and the waves played the greatest part, and that atoll lagoons tended to shoal owing to the deposition of sediment within them; that Le Conte in 1856 had said that Barrier reefs stood out from shore because they were limited on one side by the depth and on the other by the muddiness of the water, and that his pronouncement accorded with every known fact; that the question of the formation of coral structures was a zoological one and was to be solved by a study of the living zooid, and that the chief agent inimical to the growth of the zooid was the deposit of sediment.

3. New Foraminifera.—Professor P. S. Pavlovic has published in the *Annales géologiques de la Péninsule balkanique*, 1908, vi, a study of the Foraminifera of the Mediterranean beds of Servia from various

localities. A very fine *Frondicularia*, which he has called *paucicana*, is the chief novelty. Mr. Heron-Allen and Mr. Earland describe in the Journal of the Quekett Microscopical Club, April, 1909, a singular species ascribed to the genus *Technitella*, which builds itself a test entirely of echinoderm plates secured without visible cement. It was found in the Moray Firth. Remarks are made as to the singular selective powers of the Foraminifera (Arenacea) as regards their building material, parallel instances of which occur to us among the caddis-worms, certain Australian caterpillars, and the conchyliophoroid mollusca.

4. Mr. R. J. Lechmere Guppy has contributed an article on "The Geological Connexions of the Caribean Region" (Trans. Canadian Inst., 1909, vol. viii). He remarks that the hypothesis commonly called 'the Atlantis Theory' has occupied his attention since 1865, and he now offers a further statement on the subject. He concludes that there was in Tertiary times a land connexion between the Caribean region and North Africa, and a sea connexion between the Caribean Sea and the Pacific. These features probably existed in Cretaceous times, and came to an end at the close of the Miocene period, "when the final remnant of the Atlantis disappeared and the Isthmus of Panama rose above the sea level, and the last gap in the Andes was closed."

5. Warth's Igneous Rocks.—We have received from Dr. H. Warth a "Classification of Igneous Rocks according to their Chemical Composition" (reprinted from the Proc. Royal Society, Edinburgh, 1908, vol. xxviii). This is an amplification of a paper printed in the Geological Magazine for March, 1906, p. 131, and it is accompanied by an index.

6. Department of Mines, Ottawa.—In the *Summary Report* of the Geological Survey Branch of the Department of Mines, Ottawa, Canada, for 1908, the Director, Mr. R. W. Brock, calls attention to the need of a large increase in the Staff of the Survey in order to cope with the demands occasioned by the rapid opening up of the country. Field-work is, moreover, hampered in some areas by the want of accurate topographic maps, and this, it is hoped, will be remedied by the establishment of a Topographic division. The investigation of the water resources of the Dominion is becoming more and more important, and it is noted that a Well-boring Records division has been formed. The Survey is endeavouring to get in touch with the drillers all over Canada, and sample bags, etc., are sent to them which they can return free of charge. Reports on work carried out in various parts of the country are contributed by members of the field-staff, and special reports on mineralogy, palæontology, zoology, and ethnology are given by the officers in charge of those branches.

7. The Care of Natural Monuments, with special reference to Great Britain and Germany, is the title of a small book by Professor H. Conwentz, Prussian State Commissioner for the Care of Natural Monuments (Cambridge, 1909; price 2*s.* 6*d.* net). The author draws attention to various ways in which natural scenery is disfigured

and plants and animals are wantonly destroyed. He admits that a great deal has been done in this country, especially to protect monuments of archæological interest and to preserve commons and open spaces; and we are glad to note that so lately as July last steps have been taken by the National Society for the Preservation of Places of Interest for the purchase of part of Cheddar Gorge, which has for some time been defaced by quarrying operations. Geology has received attention in the preservation, sometimes in situ or by the removal and care elsewhere, of boulders and large concretionary masses of rock such as greywethers; while in Victoria Park, Glasgow, there is preserved a small tract of Carboniferous rocks with fossil trees. Geological sections opened up in soft strata are not readily to be retained, but these and openings in hard rock are too often rendered obscure and exceedingly foul by the shooting of rubbish into them—a barbarous practice that in many instances may lead to pollution of water supplies—while even at some seaside resorts that are regarded as 'salubrious', cliffs are utilized as dumping-grounds for refuse.

8. The Dawn of Human Intention.—In an essay on "The Dawn of Human Intention: an Experimental and Comparative Study of Eoliths" (Mem. Manchester Lit. and Phil. Soc., 1909, price 1*s.* 6*d.*), Professor Alfred Schwartz and Sir Hugh R. Beevor have carefully considered and summarized the reasons for belief in the artificial shaping and use of Eolithic implements. While recognizing that Eoliths are of great antiquity, dating back in this country to the Pliocene period, they follow Mr. Rutot in noting evidence of their manufacture at earlier and later periods, and therefore they propose that the term be applied to the form of the stone implements, using other terms such as *Kentien* to indicate the chronological position of the industry. The authors have made a large collection of Eoliths from the gravel of Croxley Green, near Rickmansworth, a deposit that has also yielded many Palæolithic implements of *Chelléen* type.

9. The Geological Survey of Western Australia.—Bulletin No. 32 (1908) contains three reports by Mr. Harry P. Woodward:—No. 1. "Notes on the Geology of the Greenbushes Tinfield," which is situated in the south-western division of the State upon the Bunbury Bridgetown Railway, 159 miles from Perth. Tin-ore (cassiterite) has for some years been worked in the Alluvial deposits, but the claims have been practically exhausted. Attention is now directed to the parent rocks, which consist of foliated granites with greisen, pegmatites, and quartz veins. These dyke rocks yield the tin-ore, also tourmaline and other minerals, including ores of tantalum. Much ore has been obtained by hydraulic sluicing on disintegrated and highly weathered portions of the rock-masses; elsewhere shafts have been sunk. The Reports Nos. 2 and 3 deal with the Mount Malcolm Copper-mine and with Fraser's Gold-mine in the Yilgarn Gold-field.

10. Philippine Islands.—"A Geologic Reconnaissance of the Island of Mindanao and the Sulu Archipelago" has been published by Mr. Warren D. Smith (Philippine Journ. Sci., 1908, iii). Mindanao is the southernmost of the Philippine Islands, and the Sulu Archipelago extends between it and the north-eastern portion of Borneo. Coal has

been worked on Mindanao, and some gold has been obtained in a region of schistose rocks. The Sulu group consists mainly of volcanic rocks and coral formations.

11. Museum of Practical Geology, Jermyn Street, S.W.—A Short Guide to the Museum (pp. 48, and price 1*d.*) has just been issued. It contains useful plans of the several floors of the Museum, and descriptions of the principal objects exhibited, including minerals, rocks, fossils, geological maps, and models. Many changes and improvements have been made in the display and arrangement of specimens since 1896, when the last handbook to the Museum was published. Space might have been found in this new Guide for a Table of Contents.

CORRESPONDENCE.

THE USE OF THE WORD 'LATERITE'.

Sir,—I have just seen in the last number of the Imperial Institute Bulletin (1909, vol. vii, No. i) a review of Professor J. B. Harrison's *Geology of the Goldfields of British Guiana*, in which the reviewer takes exception to Professor Harrison's use of the word 'laterite' as being "wider than is either usual or desirable" (p. 134 of the Bulletin), and the reviewer states that only products of weathering containing free aluminium hydroxide in hot, moist climates should be considered as laterite.

In the light of the recent literature on the subject, the proposition that it is desirable to restrict the term 'laterite' to that product of weathering in hot, moist climates which contains free aluminium hydroxide carries great weight; indeed, I had almost said that it is the counsel of perfection, one attribute of which it certainly possesses, namely, that it is impracticable. The reason of this is that the term 'laterite' has been used, in the Malay Peninsula at least, for many years by a large body of engineers for what are essentially masses of iron oxide replacing portions of weathered rock and filling fissures in such rocks near the surface. This (Malayan) laterite is most abundant in weathered schists, and is largely used for public works. Small quantities of aluminium hydroxide may or may not be present in these masses of ironstone, but that question is of no immediate importance to the engineer, who values the stone for its hardness.

I have talked this matter over with one of the senior officers of the Public Works Department and he agrees with me that 'laterite' is an engineer's rather than a geologist's term, covering rocks of varying composition; and I am strongly inclined to think that we should do well to call rock that we say are bauxites by their accepted mineral name, instead of attempting to lay down what shall and what shall not be called 'laterite'.

It is clear that the reviewer of Professor Harrison's book does not appreciate the difficulties awaiting those who attempt to instruct engineers in the use of the term 'laterite'. It is a task that would,